Scientific Support to Defence Decision Making and Capability

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The Defence White Paper is conspicuous in its recognition of the importance of scientific support for Australia's defence and security needs—and the key role of the Defence Science and Technology Organisation (DSTO) in this. Some areas for this support are mentioned explicitly, such as submarines, anti-submarine warfare, electronic warfare, and cyber warfare, while other important areas may be inferred, such as stealth and signature management, ballistic missile defence, and defence against chemical and biological weapons. The White Paper recognises the value of international collaboration, but the arguments on innovation seem incomplete—there is an opportunity here to provide better guidance.

Australia has a long and substantial record of recognising the importance of science to our national defence.[1] It is reassuring to see that this recognition continues. There are two continuing themes to be found here: progress in science and technology is a principal driver of change in the nature of warfare; and, for Australia, the intelligent exploitation of technology can make a disproportionately significant contribution to our national security and can partly compensate for the relatively modest size of our population.

In the 2009 Defence White Paper there is in addition a third theme. While arguing that Australia itself remains intrinsically secure, the White Paper offers a general sense of strategic gloominess. Changes in the relativities of power in the Asia-Pacific region will heighten the sense of strategic uncertainty, in turn increasing the risk of international miscalculation. Other nations are modernising their defence forces, and more-capable defence equipment is becoming more-readily available to them—thus it becomes yet more of a challenge for Australia to retain the capability edge that was so reassuringly within our reach in the early decades of the policies of defence self-reliance. The outlook continues to be disturbing with respect to terrorism, the proliferation of Weapons of Mass Destruction (WMD), and *in extremis* terrorists armed with WMD. And there are new risks to assess and counter, such as cyber warfare and space warfare.

The White Paper is perhaps ambiguous on the point, but there is a sense in its drafting which suggests that we have entered a period of strategic warning, facing a future in which circumstances will most likely become more demanding, not less. There will be a greater risk of the need to conduct

[1]The earliest antecedent of the position of Chief Defence Scientist was established in 1907, following a similar position in the Colony of Victoria in the mid-1890s. See Peter Donovan, *Anticipating Tomorrow's Defence Needs* (Canberra, Commonwealth of Australia, 2007).

operations. At least some classes of operation will be more intense. And, it is argued, the comfortable assumptions of earlier decades about the length of warning time have now become less compelling. All of these factors, together with the government's ambitious plans for the modernisation of the Australian Defence Force (ADF) and other areas such as intelligence, indicate that successful implementation of the government's policies will require scientific support of the highest order.

Like the Defence White Papers of 1994 and 2000, the 2009 publication devotes a separate chapter to defence science and technology. This is encouraging, although the text often offers more description than explanation, and can be oblique on what the criteria are for the setting of priorities—the challenge of deciding what, and what not, to do. The reader is obliged to turn to other areas of the White Paper to get a more complete picture of where and why the Defence Science and Technology Organisation (DSTO) will be working, and even here a degree of extrapolation is needed. There is an additional aspect, however: DSTO has been subjected to, and has survived, yet another review. Overall, DSTO's role has been reconfirmed: to be the principal source of independent scientific advice and a major source of Australian defence innovation. It is easy to read into the science chapter of the White Paper a sense of relief that the review is over and that the real work can now begin. This article will take a look at some of the main areas where scientific advice and support will be needed to support decision-making, and offers observations on international cooperation, innovation, and the management of defence science.

Support to Force Modernisation

SUBMARINES

Amongst the many lessons from the building of the Collins-class submarines in Australia is that it was critical to have very high levels of support from DSTO—often in areas which had not been anticipated. The importance of this for the new Future Submarines has already been recognised, with DSTO having "initiated a coordinated and comprehensive approach to the [new boats'] capability requirements". And DSTO's continuing support to the Collins-class, including to through-life maintenance and upgrades, will help position the organisation to support the new submarines too. The White Paper recognises the importance of Australian industry involvement and the crucial nature of continuing collaboration with the United States in undersea warfare. Of necessity, DSTO will have a central role in these interactions. Some specific matters that DSTO can be expected to be required to advise on, and as necessary to conduct research in, are uninhabited underwater vehicles and signature management, where the new boats will "require low signatures across all spectrums, including at higher speeds".[2] The latter is

[2] Department of Defence, *Defending Australia in the Asia Pacific Century: Force 2030* (Canberra: Commonwealth of Australia, 2009), para. 17.13, and 9.3-10.

crucial, and if experience be the guide that it usually is on this subject, Australia will have to put special effort into signature management if the submarines are to achieve the high levels of performance that the policies of self-reliance require.

SURFACE COMBATANTS

Reflecting trends in warfare and our strategic circumstances, the new major surface combatants will incorporate many capabilities that exploit advanced technology. These include a Cooperative Engagement Capability, modern air defence missile systems (and specifically the SM-6 missile), a long-range active towed-array sonar, and maritime Unmanned Aerial Vehicles (UAVs). There is also the prospect of weapons to defend against close-range surface threats such as high speed boats equipped with heavy weapons.[3] Planning and operations in all of these areas are likely to require high levels of scientific support. In addition, if experience again be a guide, there will be a need for high levels of self-reliance in the understanding and management of the new platforms' signatures. It seems, however, if only by lack of mention, that the new Air Warfare Destroyers will not be incorporating defences against ballistic missiles, so perhaps DSTO will be spared the need for research or collaboration on this specific aspect.

ANTI-SUBMARINE WARFARE

DSTO is mentioned explicitly in the discussion of a "greater emphasis on our capacity to detect and respond to submarines in the ADF's primary operational environment [POE]". DSTO "will enhance its research into underwater sensors and networking to give greater emphasis to underwater situational awareness".[4] This important development is not without its problems, not least because the POE is a vast area, extending considerably beyond Australian waters and including sea areas which other nations regard as sovereign. Further, the performance of sensors can depend critically on the characteristics of the water column and sea bed at particular locations. This includes the shallow waters and archipelagos to our north. Nevertheless, when helping to determine the best way forward for our anti-submarine (and pro-submarine) capabilities, this work has the potential extra benefit of being able to illustrate where operations would run risks of such magnitude that they should be avoided.

LAND FORCES

The move towards the *Adaptive Army* will continue the emphasis on enhanced communications, networking and battle management systems, greater precision from new weapons systems, and enhanced protection and mobility. Other initiatives include the *integrated soldier system* and tactical UAVs. In all of these areas, there will be ample scope for DSTO to contribute to better-informed decision-making, especially in those capabilities

[3] Ibid., para. 9.11-15.
[4] Ibid., para. 6.38, and 9.18.

that are being driven by technologies in the fast-moving fields of electronics, computing and simulation, and where a focus on joint operations is needed. DSTO can be presumed to continue to provide active support to the ADF's Incident Response Regiment (IRR), which has responsibilities to handle chemical, biological, nuclear, and radiological threats. Such support might also be expected to extend to the deployable defensive counter-WMD capability that the government intends to establish within the IRR.[5]

AIR POWER AND STRATEGIC STRIKE

DSTO has already been extensively involved in issues relating to air combat capability, and this can be expected to continue. Examples include research to support decisions relating to the effectiveness and fatigue life of the F/A-18 fighter aircraft, selection of the F/A-18F Super Hornet, and a wide variety of work relating to the acquisition, operations and through-life support of the F-35 Joint Strike Fighter (JSF). Signature management of all new aircraft will be important, especially if there are any sensitive *stealth* aspects. Avionics will most likely prove to be a particular area for scientific support, especially if Australian experience with previous aircraft (and other platforms) is repeated, and we find ourselves with "export" versions of equipment or software or with less than adequate access to source code.[6]

Electronic warfare (EW) can be a particular case in point - a vital yet difficult and unforgiving field, with effectiveness depending critically on getting it precisely right. Exporting governments can often be restrictive to the point of paranoia about what they will release, even to Australia. It is reassuring, therefore, to see that the government is putting a high priority on strengthening the ADF's EW capabilities—and that "DSTO will continue to undertake research and development of new and emerging EW techniques and technologies". The potential acquisition of the electronic attack EA-18G Growler would be an interesting development (as would an EA variant of the JSF), and would require high levels of scientific support and a yet-closer relationship between DSTO and the new Joint EW Centre.[7]

There is also the foreshadowed acquisition of a wide variety of new precision weapons: air-to-air missiles, air-to-ground missiles, air-launched torpedos, air-defence missiles for the Army, anti-ship missiles at some stage, and maritime-based land-attack cruise missiles (and the necessary "enhanced geospatial capabilities and targeting analysis support").[8] The latter is a challenging development, and perhaps DSTO could start by conducting an analysis of the circumstances in which it would be cost-effective for Australia to use such a capability. For all of these new weapons, there will be the issue of understanding their weaknesses as well as their strengths, and the

[5] Ibid., para. 9.27-55, 9.106, and 17.14-15.
[6] Ibid., para. 9.56-76.
[7] Ibid., para. 9.64, and 9.90-92.
[8] Ibid., para. 9.75 and 9.80.

consequences for operational effectiveness. The demands of targeting analysis could also prove formidable.

INFORMATION SUPERIORITY

The government has set important and demanding objectives for the level of Australia's Information Superiority.[9] Many complex issues come together under this heading: the wide geographical area and variety of physical conditions embraced by the POE; the wide variety of potential sensors and collectors, such as satellites, the Jindalee Operational Radar Network, human intelligence, and many others; allies' systems; data fusion; modern approaches to command, control, communications, battlespace management, command support, and networking in support of joint operations; the requirements of coalition operations; and the breath-taking rate of advance in many of the underlying technologies of electronics, computing, and systems design. Experience says that this is a field in which it is all too easy to be over-ambitious. Nevertheless, not least because of the high degree of reliance on advanced technologies, it is self-evident that this area of endeavour, in whole or in part, will require high levels of scientific support if the government's objectives are to be met in a reasonable timeframe and at reasonable risk—and sustained thereafter.

And the government "has decided to invest in a major enhancement of Defence's cyber warfare capability". This is an important development, not just for Defence but for the whole of government and the wider community, although the government appears to hedge its bets on how pressing its immediate concerns are. DSTO personnel will be amongst those to be represented in the intended Cyber Security Operations Centre.[10]

MISSILE DEFENCE

As part of its hedging against emerging areas of potential threat, the government recognises that "threats posed by ballistic missiles and their proliferation … constitute a potential strategic challenge for Australia". Such threats could include "potential direct threats to Australia", and "to deployed Australian forces … particularly in East Asia and the Middle East". Correctly, the White Paper puts great store by the need to preserve the stability of the nuclear balance between the major nuclear powers. Nevertheless, there is just a whiff of *Old Labor* and confusion in the paper's opposition to "the development of a unilateral national missile defence system by any nation". In spite of these reservations, the government

> will explore the development of capabilities for in-theatre defence of ADF elements and the defence of other strategic interests—including our population centres and key infrastructure.

[9] Ibid., para. 9.77-96.
[10] Ibid., para. 9.85-89, and 9.97-98.

When it "review[s] its policy directions in this field annually" and "authorise[s] an annual plan of Defence engagement, research and development activities", today's Labor Government might do well to remember the collaboration that it supported in this field when Labor was last in office.[11]

OTHER ASPECTS OF SUPPORT

It is good to see the recognition of DSTO's support to ADF operations, including through the deployment of personnel into areas of operation and the use of rapid reach-back to the defence science base in Australia. There is a long tradition of such support—for example in East Timor and Viet Nam as well as the ADF's current operations—which is not always remembered.[12] In a similar way, it is important to recognise the importance of DSTO's support to the current force, both in terms of maintaining and improving levels of operational effectiveness, and the safe and efficient use of platforms. The former will become yet more important with the prospect of more operations and reduced warning time, especially in the complex and often rapidly-changing fields of measure and countermeasure. DSTO's record in the latter is outstanding, especially in extending the safe operational lives of fatigue-limited airframes; it is a pity that the huge savings that this work has lead to are not more widely known. Finally, it is also noteworthy that DSTO's support to security agencies beyond Defence is endorsed, in spite of there having been a need for "greater clarity" in this area. It is self-evident that this support should be available, including in the areas mentioned, such as defence against chemical and biological agents, the countering of improvised explosive devices, and in cybersecurity.[13]

International Cooperation

Not unexpectedly, and as has been the case with every previous Defence White Paper, the 2009 document confirms that our most important defence relationship is with the United States. Areas in which the two countries are committed to fostering cooperation include technology access and acquisition, missile defence, and research, development, test and evaluation. Fields of research that the White Paper identifies for this are intelligence, surveillance and reconnaissance, cyber warfare, electronic warfare, underwater warfare, and networked systems.[14]

The chapter on *Defence Science and Technology* develops this theme further. It says that collaboration with friends and allies, particularly the United States, will become a more critical element of Australia's strategic capability advantage. It says that, for its part, the United States "will seek technology collaboration with trusted partners in the development of new

[11] Ibid., para. 9.102-105. See, for example, Richard Brabin-Smith, *Australia and Ballistic Missile Defence*, Strategic Insights, no. 5 (Canberra: Australian Strategic Policy Institute, 2004).
[12] Department of Defence, *Force 2030*, para. 17.11.
[13] Ibid., para. 17.8, 17.12, and 17.22-23.
[14] Ibid., para. 11.5-9, and 17.25.

systems", and that Australia will be "well placed to cooperate in such endeavours". There is also a note of caution, albeit oblique:

> the transfer of especially sensitive technologies, which are likely to give US forces a winning edge, will be restricted to a few very trusted partners and controlled carefully.

This is the closest that the White Paper comes to making the important point that even the closest of friends can be recalcitrant at times, with far-reaching consequences about the steps that Australia needs to take to become confident about the performance of the ADF's critical electronic and other systems.[15] However, at least partly to counter this, the text also makes the correct point that

> by undertaking world-class research in certain niche areas, and through international collaboration, Australia is able to access overseas capabilities that would not otherwise be available to the ADF.[16]

The key here is that by putting its own high-quality and defence-relevant intellectual property on the table, DSTO can open doors that would otherwise be a significant barrier.

Australia's international partners in defence science also include the United Kingdom, Canada and New Zealand, including through The Technical Cooperation Program, and a variety of other European countries. The White Paper suggests that shared operational interests and concerns have served to reinforce the value of these international science connections. Japan, alone of all other countries, attracts "a commitment to explore cooperation in science and technology". This is not a new thought, and many years have passed with little progress, even in such potentially non-controversial areas as airframe fatigue. Potential collaboration with Japan in, say, ballistic missile defence or new submarines, would likely prove too ambitious in the early years of any collaborative program.[17] There is no mention of DSTO's collaborative arrangements with several of the ASEAN countries: Indonesia, Singapore, Malaysia, and Thailand. Some of these arrangements are, or have been, quite substantial. Whether this omission is through drafter's licence or for more significant reasons is not clear.

Innovation

The White Paper offers an incomplete and perhaps confusing picture on its approach to innovation. On the one hand, it provides clear recognition of the need for innovation and a commitment to be innovative, for example:

> Defence will explicitly plan to maintain a strategic capability advantage, and to achieve it through capability development strategies, self-reliant defence

[15] Ibid., para. 17.3-4.
[16] Ibid., para. 17.25.
[17] Ibid., para. 11.14, 11.38-41, and 17.25.

> research, development and innovation, and collaborative programs with scientifically and technologically capable partners. This will include a continued focus on new technologies and their exploitation and application.[18]

On the other hand, it also says that Defence will continue to drive down the costs of ownership of military capability. "This [approach] will include … where appropriate, a bias towards military- and commercial-off-the-shelf capabilities".[19] This point is reinforced in the chapter on *Procurement, Sustainment and Industry Support*, where we find that

> The Government intends to make informed decisions about the appropriate mix of cost, risk and capability. Consequently, the Government has decided that military-off-the-shelf and commercial-off-the-shelf solutions of Defence's capability requirements will be the benchmark against which a rigorous cost-benefit analysis of the military effects and schedule aspects of all proposals will be undertaken.[20]

Experience suggests that, in the wrong hands, this could easily be interpreted in practice to mean hostility towards, or only limited tolerance for, Australian innovation.

Nevertheless, in spite of this sense of caution, Defence will also "adopt procurement and industry strategies to grow industry capacity and competitiveness", and the "Government is committed to ensuring that certain strategic industry capabilities remain resident in Australia". To this end, the Government intends to establish priority industry capabilities (PICs), which

> confer an essential strategic capability advantage by being resident within Australia, and which, if not available, would significantly undermine defence self-reliance and ADF operational capability.[21]

While it is true that the text includes "research and development activities" amongst the roles of the Centres of Excellence that will be set up to compensate for "any identified capability and capacity shortfalls in PIC categories", nowhere does it mention *innovation*. Instead the reader is left to infer where the priority areas for Australian innovation might be. The broad range of industry capabilities that the government intends to monitor to help support its decisions on the PICs does offer some clues, although even here the term used is "development" rather than "research". The list includes such topics as EW development, cyber defence, life-extension of ADF systems, underwater acoustic technologies, and signature management.[22]

All of this is potentially useful, but it is disappointing that, after thirty-plus years of the policy of defence self reliance, this is only work in progress and

[18] Ibid., para. 8.53-57.
[19] Ibid., para. 8.66.
[20] Ibid., para. 16.17.
[21] Ibid., para. 16.19-21.
[22] Ibid., para. 16.23, and 16.26.

is not yet fully-developed policy. Much more remains to be done, both to develop the policies and to implement them.

As would be expected, the chapter on *Defence Science and Technology* does address innovation, although even here there are few direct references. On the one hand, the White Paper review of Defence Science and Technology examined *inter alia* those capabilities required to "innovate and adapt generally available technology for Australia's specific defence purposes"; on the other hand, there is no explicit mention of innovation in the summary of the Review's findings or the summary of DSTO's mission. Support for innovation is implied by the commitment to continue with the Capability Technology Demonstrator Program. And the final sentence of the chapter says that an enhanced external engagement program "will focus on the critical science and technology areas where Australia must innovate in order to maintain its strategic capability advantage."[23]

It is important not to be obsessed by the omission of a substantive discussion of innovation, as in some respects the White Paper is suffused with recognition that Australia's defence will rely on increasing levels of innovation. But this would be to miss the point. Experience tells us that success in innovation policy and in innovation itself is difficult, both in general and specifically within Defence. Defence would do well to take to heart the observations of the government's recent policy paper on innovation, *Powering Ideas*, which not only recognises that "Innovation is the key … to the challenge of national security" but also that

> innovation requires sustained commitment, sometimes for decades. Translating new ideas into money-making products and services takes staying power. It requires an innovation system that offers an unbroken path from vision to realisation.[24]

Overall, the lessons on innovation are that it is complex and difficult, requiring a well-developed conceptual framework within which to trade off cost, benefit and risk—that is, to have robust criteria and processes for deciding what to do and what not to do, and why. It is a challenge which the new force structure and capability development process that the government is promising could usefully pick up.[25] If handled properly, it would offer the benefit of a better focus to Defence's industry policy, better guidance to Defence's innovation programs, more substance to collaboration between DSTO and Australian industry, and the more secure and continuous funding that innovation needs if it is to be successful.

[23] Ibid., para. 17.7-9, 17.24, and 17.26.
[24] Department of Innovation, Industry, Science and Research, *Powering Ideas* (Canberra: Commonwealth of Australia, 2009), pp. 1-3.
[25] Department of Defence, *Force 2030*, para. 8.72-74.

The Management of Defence Science

From time to time over the years, DSTO has been subjected to what might be called severe and uninformed attack. Such criticism contributed to the reasons behind the review of DSTO which the White Paper mentions. Yet the review seems to have found little wrong with DSTO's work program, with the main concerns being more with the need for improved transparency, to which new governance and management arrangements are designed to contribute.[26] As a result of the review and in light of Australia's emerging strategic circumstances, DSTO is now set to expand.

As far as can be seen from the outside, DSTO has already established a presence in the areas where the government has now expressed increased levels of strategic concern, such as defence against cyber attack, chemical and biological agents, and ballistic missiles. It is perhaps self-serving to say so, but this speaks well of DSTO's ability to anticipate future concerns, and it is heartening to see that the government intends that DSTO will continue a significant program of research into forward-looking enabling technologies.[27] This focus on the future is one of the many aspects of DSTO's program that must continue to be actively managed.

Why does defence science come under attack from time to time? Is it just a question of transparency and communication or is there more to it than that? Is it that the scientific version of "frank and fearless advice" can on occasions be too unwelcome? In any event, the management arrangements for DSTO need to continue to safeguard its ability to give impartial advice, to foster the professional quality of its scientific work, and to maintain the work's focus on the priorities of Australia's defence and security.

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[26] Ibid., para. 17.7-8, and 17.19-20.
[27] Ibid., para. 17.16.