

**INQUIRY INTO BUSINESS COMMITMENT TO R&D IN AUSTRALIA:
SUBMISSION FROM ANSTO TO THE HOUSE OF REPRESENTATIVES
STANDING COMMITTEE ON SCIENCE AND INNOVATION**

Introduction

The Australian Nuclear Science & Technology Organisation (ANSTO) is Australia's national nuclear organisation and the centre of Australian nuclear expertise. Its mission was formulated to fulfil its functions as specified in the *ANSTO Act* 1987. The first component of its mission relates to advice to government and national strategic and nuclear policy objectives. The other three components of its mission give it a strong interest in the level and strength of business commitment to research and development (R&D) in Australia. These three components of its mission are as follows:

- to operate large nuclear science and technology (S&T) based facilities in Australia and overseas for the benefit of industry and the Australian R&D community...;
- to undertake research on specific topics to advance the understanding of nuclear science and the nuclear fuel cycle; and
- to apply resulting technologies and other relevant, unique capabilities to focussed R&D and other scientific activities to increase the competitiveness of Australian industry and improve the quality of life for all Australians.

Business commitment to R&D is a vital element of Australia's national innovation system. R&D performed within businesses or transferred to businesses from other organisations leads to the generation of new products and services, and improvements in existing products and services. These lead to triple bottom line benefits: enabling firms to operate more productively and profitably, enhancing quality of life in Australian society, and protecting and enhancing our natural environment.

In this submission to the House of Representatives Standing Committee on Science and Innovation's Inquiry into Business Commitment to R&D, ANSTO particularly focuses on the following two questions that the Inquiry has asked:

- What are the impediments to business investment in R&D?
- What steps need to be taken to better demonstrate to business the benefits of higher private sector investment in R&D?

This submission first identifies the forms of business R&D in which ANSTO is involved and then examines ways in which business commitment to R&D could be improved by removing impediments to increased return on investment (ROI), and demonstrating to business the benefits of its investment in R&D.

Forms of business R&D

Business R&D is broader than the R&D that businesses undertake themselves. It also includes the R&D that business commissions from government-funded S&T organisations, as

well as universities and private sector research providers. In addition, it could be considered to include business absorption of published or commercialised results of R&D undertaken in the past and the use of capabilities developed through prosecution of research, as these, too, draw on the national R&D effort.

These forms of business R&D are not rigid categories. For example, ANSTO has business units that invest in R&D on a similar basis to any other business investing in R&D, and businesses may perform R&D on their own or in collaboration with others. Businesses' ability to effectively absorb R&D performed by others is determined by the level of learning, or R&D, that takes place within the business.

It is also important to note that some R&D may be tactical, to address specific or short-term issues or opportunities that a business faces, but other research may be strategic and designed to build longer term capabilities or open up longer term opportunities.

Table 1 sets out a range of mechanisms for business R&D in addition to conducting it wholly in-house, and illustrates them with examples from ANSTO's experience and R&D portfolio.

Table 1

Mechanisms for business R&D	Example
<p>Research contracted and funded by individual businesses and industry associations</p>	<p>ANSTO was contracted by an Australian company to develop silicon carbide ceramics for armour applications. The technology has since been licensed internationally.</p> <p>The Organisation provides research services to most major Australian mining companies. This includes providing hydrometallurgy and chemical engineering services on a contract basis, focusing on processing of radioactive ores.</p> <p>ANSTO Radiopharmaceuticals and Industrials (ARI), an ANSTO business unit, undertakes R&D.</p>
<p>Formal structures for joint research such as Cooperative Research Centres (CRCs) and centres of excellence</p>	<p>ANSTO is a partner in the CRC for Polymers, the CRC for Welded Structures, and the CRC for Waste Management and Pollution Control. It collaborates with others, such as the CRC for Microtechnology and the CRC for Landscapes, Environment and Mineral Exploration. A new round of CRCs is being selected, and ANSTO is a participant in the consortium for the proposed CRC for Contamination Assessment and Remediation of the Environment and intends to participate in the proposed CRC for Sustainable Resource Processing.</p> <p>The Organisation was a participant in a consortium that was shortlisted for the Biotechnology Centre of Excellence.</p>
<p>Collaborative research projects in which various parties conduct elements of the research</p>	<p>ANSTO collaborated with an Australian company and other research organisations in the early stage development of photo-chromic solar cells. Pilot scale production is now established at the company's facilities.</p> <p>In another collaboration, ANSTO and Pacific Power developed methodologies for assessing plant life reduction under various operating regimes in thermal power stations.</p>

	These methodologies are now used by both organisations in consultancies to power stations in Australia and overseas.
Joint development work for a new product or process in which parties may hold ongoing business interests	Joint development work often builds on ANSTO's unique capabilities and facilities. For example, using the Organisation's ceramic processing capabilities, ANSTO and an Australian ceramics company jointly developed aluminium titanate thermocouple sheaths, which the company has since extended to a range of aluminium titanate products.
Application of published results of research	Publication of results of accelerator mass spectrometry (AMS) research results has generated new business for ANSTO, for example, in archaeology. AMS is an ultrasensitive dating and isotope tracing technique.
Use of products and services based on research	Acid mine drainage is one of the areas in which ANSTO has developed unique expertise, instrumentation and software over many years. The Organisation provides this through Sulfide Solutions, in order to develop and promote commercial opportunities in this area. Customers are located around Australia and many parts of the world.
Taking up technologies through licence arrangements and the like	ANSTO can identify four licensing arrangements finalised or under way. For example, it is commercialising its patented surface treatment process known as Plasma Immersion Ion Implantation (PI ³ ™). PI ³ improves the wear performance, corrosion resistance and hardness of metal surfaces. It has applications in machine tools and precision dies and for industries ranging from automotive and aerospace to food and chemical processing.
Investment in spin-offs	ANSTO can identify nine businesses built on technologies that were developed with ANSTO or its predecessor.
Consulting projects, drawing on researchers' existing expertise (that is, not involving significant new research)	ANSTO has made assessments of the remaining life of many components of high temperature plant through consultancies with numerous Australian power utilities, oil refiners and chemical manufacturers over the past 15 years.

Business R&D support services and spillover benefits

S&T organisations such as ANSTO provide a range of services and spillover benefits to support business R&D, in addition to conducting research. These supplement or extend businesses' own resources. Table 2 lists a number of such services and benefits, illustrated by examples of their application at ANSTO.

Table 2

R&D support	Example
Access to research facilities, and	Business uses the nuclear research reactor, particle accelerators and other nuclear infrastructure at ANSTO on a

associated expertise, within Australia	<p>paid service basis. For example, mineral and environmental samples for minerals prospecting and processing, and for environmental management are irradiated in the reactor for highly sensitive composition analysis. Neutron beams from the reactor are used for structural characterisation of minerals.</p> <p>ARI has a strategic partnership with SIRTeX Medical in the treatment of secondary liver cancer using particles containing radioisotopes. The radioisotopes are produced in ANSTO's research reactor.</p>
Access to research facilities, and associated expertise, in other countries	The Access to Major Research Facilities Program supports access by Australian researchers from industry, private and public research organisations and universities to major international research facilities not available in Australia. ANSTO administers this program. In addition, ANSTO manages the Australian Synchrotron Research Program at facilities in Japan and the USA.
Research support services	ANSTO provides radiation protection training and consultancies, utilising services that it initially developed to meet its own internal needs.
Proximity benefits of location on the site of or near research organisations, such as in S&T parks or centres	A number of high-technology organisations are co-located with ANSTO at the Lucas Heights Science and Technology Centre.
Hiring personnel who have been trained or gained experience in research organisations	Individuals who have worked at ANSTO have had experience in the application of nuclear technology and techniques to a broad range of industrial problems and opportunities. In addition, the Australian Institute of Nuclear Science and Engineering provides university researchers and undergraduate and postgraduate students with access to ANSTO facilities, thus deepening the knowledge that they can offer employers following graduation.

Maximising the value to business of S&T organisation R&D capabilities

In examining the impediments to business investment in R&D and considering the steps needed better demonstrate to business the benefits of higher private sector investment in R&D, it is important to view research and development as being part of the national innovation system. A national innovation system is formed by institutions and the linkages between them. These institutions can be formal institutions or organisations, such as governments, companies, education institutions and S&T organisations. Or they can be broadened to include laws, regulations and “things that pattern human behaviour”¹. It is also important to recognise that, in practice, R&D is not a linear process, but rather incorporates feedback loops and spillovers from one organisation or area into another.

¹ Ehrnberg E and Jacobsson S (1997), “Technological Discontinuities and Incumbents’ Performance: An Analytical Framework”, Charles Edquist (ed), *Systems of Innovation: Technologies, Institutions and Organisations*, Pinter, London and Washington, p.330

Because innovation is systemic and not linear, a business may not consider the breadth of the returns it has gained when it assesses return on investment (ROI). For businesses to maximise the value of R&D capabilities that are to be found at S&T organisations, they require an appreciation of the contribution that R&D can make to the firm's objectives; a positive ROI in R&D; and the capacity to absorb the R&D. Each of these is discussed below.

Awareness

Impediments to business commitment to R&D related to awareness factors include awareness of, and confidence in, the potential contribution that R&D can make to business strategies, and of the technologies and facilities that businesses can utilise. Following are some ways in which these impediments could be addressed, by businesses, governments, R&D organisations and associations.

Increase generic appreciation of innovation – Government has an important role to play in building awareness of the spectrum of benefits of R&D to business. Government programs also contribute to awareness of commercialisation among researchers, which encourages the transfer of research into business through the movement of researchers into the private sector or the creation of business units within, and spun out from, research organisations.

Provide real evidence of the benefits – A particular impediment to business R&D is the all-too-common perception that R&D is a cost rather than an investment. This could be addressed in part through case studies with demonstrated financial benefits of R&D, including ROI analyses on R&D expenditure in a number of companies over short and longer timeframes. These might be aimed especially at small and medium sized enterprises (SMEs), as globally successful manufacturing companies do not have the same need to be convinced of the need for R&D. (In their case, one issue is that larger manufacturing companies which in the past carried out substantial amounts of R&D in Australia have gone off shore and very substantially reduced their R&D activities here.)

Increase awareness of benefits of particular technologies – S&T organisations, business groups, university researchers, private sector researchers and government all contribute to awareness of the potential that particular technologies can offer to business R&D programs. Examples include the contribution that Biotechnology Australia has made to public debate regarding biotechnology. Industry associations could play a greater role in building such awareness as could clusters of R&D facilities focusing on particular technologies. A specific impediment, therefore, may be an inadequate number of clusters or insufficient support to facilitate clustering.

Increase awareness of Australia's research capacity – A lack of awareness of the research capacity available in Australia, as well as overseas, can be an impediment to businesses expanding their R&D programs. S&T organisations, business groups, individual businesses, universities and government contribute to awareness of the R&D facilities and services that are available to business. Examples of such activity include the workshops that ANSTO has been undertaking with business regarding the world-class neutron scattering facilities that will be available on its replacement research reactor. Statements and publications by Ministers, other parliamentarians and departments also promote awareness of the facilities and services that are available.

Encourage and facilitate business monitoring of developments – Businesses become aware of R&D that may be relevant and useful through monitoring R&D developments externally.

An impediment to business R&D may be a lack of staff or consultants who can appreciate the potential impact of these developments. This may reflect inadequate management appreciation of the importance of having skilled personnel engaged in this activity, as well as the level of science, engineering and technology (SET) skills available to business.

Communicate positive experience – An impediment to business commitment to R&D can be simply a lack of practical experience or awareness of relevant experience of others. Business experience in commissioning research from organisations, collaborative research and using the outcomes of research all encourage further R&D activity. Case studies of the experience of others can have a similar effect.

Build on the national research priorities – One expected benefit of national research priorities will be greater awareness of the outputs and capacity of Australian research-performing organisations within the nominated priority themes. It is important to note that the success of the research priorities program will be determined not only by the undertaking of new research, but also by the extent of knowledge diffusion to business. Until now Australia has not had many areas of national focus, and those that it has have not necessarily been high-profile. This may have been an impediment to business R&D, as firms may have preferred to participate in concentrated research programs, not been aware of the nation's research capacity in areas of national importance or not seen the potential benefits to the firm in engaging in R&D in these areas.

Return on investment

Businesses that are aware of the potential that R&D can offer them may still not commit to R&D activities due to the return being regarded as too low to justify the investment. Impediments to achieving a sufficiently high return could include small markets, difficulties accessing overseas markets, a lack of demand for innovative products and services, and insufficient financial reward for leading innovators. Impediments to investment could include incentives that are not large enough to significantly change the ROI or are difficult to access, as well as conditions that raise costs of financing R&D or regulations governing marketing of innovations. Following are some ways in which the revenue from R&D could be increased and the costs reduced to improve ROI in business R&D.

Use research excellence to expand markets – Research that is of the highest standard internationally provides a foundation for Australian business to increase its international competitiveness – both on the home front against foreign competition and in international markets. Current impediments may be businesses not appreciating the opportunities that are raised by world-class research in Australia and fragmentation in the national research effort.

Encourage growth in export markets – The international reputation of Australian R&D can contribute to export sales of products and services, and government can influence this reputation through export incentives and international marketing efforts, as well as by encouraging research excellence. A recent example was the Australian presence at Hannover Fair in 2002, which was supported by the Department of Education, Science and Training.

In addition, Australia's international standing and its multilateral and bilateral relationships can affect its exports. This should not be neglected in a whole-of-government approach to business R&D.

Drive market growth through pressure to innovate – Regulatory changes, demanding customers – including government customers, innovative suppliers and a competitive business environment all encourage companies to be innovative. They both open new opportunities and bring to an end existing practices, processes and product ranges. For example, new health regulations and environmental objectives can provide an incentive for Australian industry to carry out more R&D or require that it does so. A reluctance to change regulations, targets and the competitive environment may reflect important government policy goals in some areas, but may also be an impediment to business R&D. (As noted below, unnecessarily complex regulation can itself be an impediment to R&D.)

Provide first-to-market incentives for new technology – For example, innovation in pharmaceuticals would be stimulated by the provision of larger Pharmaceutical Benefit Scheme payments to the first new drug in a class of drugs.

Support long-term business development – Another notable impediment to business R&D is the preparedness of some companies to adopt a long-term view and consequent strategy. Companies are driven to take such a view by shareholders, financiers, investment analysts and management responding to incentives that reward short-term action and disregard long-term investment. This raises the cost to the business – and managers personally – of long-term investments in R&D. ‘Short-termism’ is an impediment particularly to R&D that is strategic and designed to build capabilities or opportunities in the medium to long term.

Correlate R&D incentives with broader government programs – R&D incentive programs have played a key role in building Australia’s biotechnology industry, for example. ANSTO has suggested that an impediment to the nation deriving maximum benefit from national research priorities might be that they are not linked to increasing business demand for R&D through R&D incentives and the like.

Ensure fair pricing of research facility access – Access to facilities should be priced in a way that is fair to both business and the Australian public, which is the major source of funding through the taxation system. ANSTO recognises this in its *Business Guidelines*.

Reduce regulatory barriers to reduce investment costs – A more consistent regulatory system would be an international competitive advantage for Australia. Different regulations across State and Federal jurisdictions complicate compliance and in doing so, raise costs to business and reduce ROI. Relevant areas of regulation include consumer protection, dangerous goods and standards.

In addition, greater consistency or homogenisation of regulation with the USA and the European Union (EU) would reduce business and research costs. The process of registering products and devices through the Therapeutic Goods Administration, for example, could be made more efficient and effective by further strengthening recognition agreements between Australia, the USA and the EU.

Ensure affordable access to finance for investment in R&D – Australia’s financial infrastructure plays a key role in enabling businesses to upgrade their technological capabilities as well as in funding the development of innovations. The cost of finance is a factor in ROI (in addition to the challenges that businesses sometimes face in accessing *any* suitable form of finance to support R&D).

Absorptive capacity

Absorptive capacity can be defined as the ability of business (or other type of organisation) to identify commercially useful information, knowledge and technology from outside the business, and acquire and apply it. A neglect of the importance of absorptive capacity has been an impediment to Australia being able to maximise the benefits of R&D within, and available to the private sector. Some ways in which absorptive capacity could be increased are highlighted below.

Build recognition of importance of learning within businesses – Businesses need to build their own absorptive capacity through R&D and other forms of learning to enable them to maximise the benefits of R&D from S&T organisations such as ANSTO. SMEs, as well as large companies, should aim to maintain at least a core group people with R&D skills, experience and responsibilities. Otherwise they find it very difficult to transfer technology in and out.

Support SET education– The education system and science and technology organisations such as ANSTO educate Australians in undertaking R&D; investigating, monitoring and interpreting R&D developments externally; designing and modifying technologies; and working with research-performing organisations. TAFE training and undergraduate education are important, but staff with postgraduate qualifications and research experience are likely to play particularly important roles in promoting innovation in firms.

Australia needs to increase the supply of, and demand for, quality graduates and postgraduates with skills in science, engineering and technology. The decline in the number of students studying enabling sciences – in particular, physics, chemistry and mathematics – causes significant concern to ANSTO in respect of its own operations, and is a significant risk to national capabilities in the medium term. ANSTO would welcome changes in relative levels of Higher Education Contribution Scheme payments for SET programs at university, to remove a financial disincentive to studying SET courses relative to some other courses. The Organisation would also welcome measures to ensure sufficient numbers and quality of teaching staff in SET faculties.

The incorporation of innovation studies into management education, training and awareness programs would also improve understanding within Australian management of the importance of maintaining absorptive capacity.

Encourage and support learning by working together – Collaborative research facilitates a tacit transfer of knowledge between business and S&T organisations. It enables business to improve its understanding of research processes and furthers the experience of its personnel. It develops a common parlance, trust and greater awareness of lateral benefits. Complementing this is the increased understanding of business needs that research-performing organisations gain.

Among the impediments currently to collaborative research are restrictions on participation in some collaborative programs, for example in excluding ANSTO, and the lack of recognition in some current and proposed funding programs of the inherent costs in collaboration, such as communication and travel.

ANSTO would like to see more organisations aiming to maintain strategic alliances and networks with public S&T organisations, to build capacity and opportunities over the long term.

Conclusion

A systemic approach is necessary to increase the level and strength of business commitment to R&D. This involves greater appreciation of the way innovation contributes to business bottom lines (including triple bottom lines), a more comprehensive understanding of the research capabilities available within Australia and how to access research facilities elsewhere; and measures to enable and encourage businesses to increase their own R&D and absorb R&D from elsewhere. A whole-of-government approach to increasing business commitment to R&D would span education, R&D, taxation, health, trade, foreign affairs and industry policy.