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# The Foundations of Innovation: Education and Research

## Australia's Innovation System

2.1 The Department of Industry, Innovation and Science (DIIS) advocated that 'innovation activities are best optimised in the context of an innovation system'.[1] An innovation system was defined by DIIS as:

> … an open network of organisations to produce and use knowledge and technology to create economic and social value. It is about the way these organisations interact to generate and exploit knowledge and ideas.[2]

2.2 Professor Roy Green also provided a definition of an innovation system stating that it was comprised of:

> … the relationships between knowledge creating organisations (principally research and education bodies), knowledge adopters (industry and the businesses that constitute it) and government (in its policy, funding, market creation and regulatory roles). Financial institutions, including venture capital investors, innovation intermediaries, professional advisers and consultants all play an important financing, enabling and integrating role.[3]

2.3 The Australian Academy of Science (AAS) highlighted the economic importance of a 'well-functioning innovation system with the capacity to continually produce new and improved goods and services'.[4] The AAS

1 Department of Industry, Innovation and Science (DIIS), *Submission 31*, p. 2.

2 DIIS, *Submission 31*, p. 2.

3 Professor Roy Green, *Exhibit 5: Australia's Innovation Future: Committee Expert Consultant Report for Senate Economics References Committee's Inquiry into Australia's Innovation System*, p. 3.

4 Australian Academy of Science (AAS), *Submission 3*, p. 6.

outlined four components of an innovation system, each of which 'has different needs but is vital to the success of the whole'.[5] The AAS described these four components as:

- a strong research sector producing important basic discoveries;
- applied scientists and engineers taking those general, basic discoveries and using them to solve specific problems in diverse disciplines;
- innovative investors, entrepreneurs and companies making connections between the fruits of research and development and opportunities in the market; and
- larger experience-rich firms providing discipline, infrastructure and networks to scale prototypes to production.[6]

2.4 The Government has identified priority areas for business innovation and development through the Industry Growth Centres and for public sector research through the National Science and Research Priorities.

2.5 The DIIS stated that the Government was investing $248 million over four years in six Industry Growth Centres focussed on 'areas of competitive strength and strategic priority'. The Growth Centres 'will work to unlock commercial opportunities and drive innovation by building links between businesses and industry organisations and the science and research sector'.[7] The six Industry Growth Centres are:

- Advanced Manufacturing
- Cyber Security
- Food and Agribusiness
- Medical Technologies and Pharmaceuticals
- Mining Equipment, Technology and Services
- Oil, Gas and Energy Resources.[8]

2.6 The National Science and Research Priorities (Research Priorities) were developed in consultation with the former Chief Scientist Professor Ian Chubb AC. A proportion of Australia's research investment will be aligned to the Research Priorities to help build 'critical mass and scale in areas vital to our future'.[9] The nine Research Priorities are:

5 AAS, *Submission 3*, p. 7.

6 AAS, *Submission 3*, p. 7.

7 DIIS, *Find out about the Industry Growth Centres Initiative*, http://www.business.gov.au/advice-and-support/IndustryGrowthCentres/Documents/IndustryGrowthCentres-Overview.pdf Accessed 19 April 2016.

8 DIIS, *Find out about the Industry Growth Centres Initiative*, http://www.business.gov.au/advice-and-support/IndustryGrowthCentres/Documents/IndustryGrowthCentres-Overview.pdf Accessed 19 April 2016.

9 The Hon Tony Abbott MP, Prime Minister and the Hon Christopher Pyne MP, Minister for Education and Training, 'National Science and Research Priorities', *Joint Media Release*, 26 May 2015.

- Food
- Soil and Water
- Transport
- Cybersecurity
- Energy
- Resources
- Advanced Manufacturing
- Environmental Change
- Health.[10]

2.7 The Australian Government budgeted expenditure on science, research and innovation was $9.7 billion for 2015-16. This funding was comprised of:

- $3.2 billion in support for the business sector (predominantly through the R&D Tax Incentive);
- $2.8 billion in support for the Higher Education sector (primarily through university block research funding and Australian Research Council grants);
- $1.9 billion for 'multi-sector' funding for large grant schemes such as the National Health and Medical Research Council (NHMRC) and the Rural Research and Development Corporations; and
- $1.8 billion for government research activities such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Defence Science and Technology Organisation.[11]

## Performance of Australia's Innovation System

2.8 The performance and strength of an innovation system is based on the dynamic interaction of a wide range of separate components. The Global Innovation Index (GII) is a widely recognised measure that attempts to 'capture the multi-dimensional facets of innovation' in order to provide an overall synthesis of the performance of national innovation systems.[12]

10 Australian Government, Science and Research Priorities, http://www.science.gov.au/scienceGov/ScienceAndResearchPriorities/Documents/15-49912%20Fact%20sheet%20for%20with%20National%20Science%20and%20Research%20Priorities_4.pdf Accessed 19 April 2016.

11 DIIS, *Submission 31*, p. 4.

12 Cornell University, INSEAD, and WIPO, *The Global Innovation Index 2015: Effective Innovation Policies for Development*, p. 419.

2.9 Australia ranked 17th in the 2015 GII.[13] While Australia ranked relatively highly the CSIRO highlighted that Australia compares 'poorly' with its 12th world ranking 'for nominal Gross Domestic Product (GDP).'[14]

2.10 In 2013-14 Australia's gross spending on research and development (R&D) (which includes government, business, and university spending) was $33.5 billion which amounts to 2.12 per cent of Australia's GDP.[15] This puts Australia's R&D spending[16] above the Organisation for Economic Co-operation and Development (OECD) average of 2.02 per cent.[17] As the CSIRO highlighted, however, 'countries with strong international reputations for innovation… spend a minimum of 3 per cent of GDP on R&D per annum.[18]

2.11 Australian business spent $18.8 billion on R&D in 2013-14, which amounted to 1.19 per cent of Australia's GDP. In the same period, Australia's higher education sector spent $9.6 billion on R&D, which amounted to 0.63 per cent of Australia's GDP.[19] As a percentage of GDP, Australia's R&D spending by business and the higher education sector ranked 15th and 8th, respectively, amongst the 34 OECD+[20] countries surveyed.[21]

2.12 In 2015, Australia ranked 10th for Innovation Input[22] but 24th for Innovation Output.[23] Australia was ranked 72nd for Innovation Efficiency, or the ability to translate inputs into outputs.[24] The CSIRO stated that Australia's low efficiency ranking 'reflects Australia's weakness in commercialising and exporting the innovations Australia creates into new market-ready products and services'.[25]

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13 Out of 141 countries. Cornell University, INSEAD, and WIPO, *The Global Innovation Index 2015: Effective Innovation Policies for Development*, p. 167.

14 CSIRO, *Submission 43*, p. 4.

15 DIIS, *Australian Innovation System Report 2015*, p. 123.

16 As a percentage of GDP.

17 This is the average for the OECD+ which includes all the countries of the OECD as well as China, Taiwan and Singapore.

18 CSIRO, *Submission 43*, p. 7.

19 DIIS, *Australian Innovation System Report 2015*, pp 109, 110, and 123.

20 The OECD+ includes all the countries of the OECD as well as China, Taiwan and Singapore.

21 DIIS, *Australian Innovation System Report 2015*, pp 110, and 123.

22 The GII rating for Innovation Inputs is based on rating a country's performance across the five criteria of: institutions, human capital and research, infrastructure, market sophistication, and business sophistication.

23 The GII rating for Innovation Output is based on rating a country's performance across the two criteria of: knowledge and technology outputs, and creative outputs.

24 Cornell University, INSEAD, and WIPO, *The Global Innovation Index 2015: Effective Innovation Policies for Development*, p. 167.

25 CSIRO, *Submission 43*, p. 4.

2.13 The Chief Scientist for Australia (Chief Scientist) highlighted Australia's weakness in transforming research into economic benefit and stated:

> … the imbalance in the entrepreneurial pipeline from R&D to economic output is a significant barrier to Australia's growth as an innovator, and will need to be addressed if Australia is to develop its knowledge economy.[26]

2.14 Sendle conceptualised innovation systems as comprising 'stocks and flows' and contended that Australia had strong stocks but weak flows. Sendle stated:

> … if you look at the innovation system in Australia, there are two things that matter in it: stocks and flows. Our stocks in the innovation system are our bodies of knowledge. They are our people. They are the universities, the CSIROs and others. The thing about Australia is that we actually have pretty good stocks for our size on the world stage. Our stocks are good, but the other [way] you can measure the innovation system is by the flows: how much knowledge is being transferred between these organisations—from the public service to the private sector; how often is knowledge going through; what are our flows like between Australia and the rest of the world? And, if there is one area where I think we need to lift our game internationally, it is the flows within the innovation system.[27]

2.15 One of the strengths of Australia's innovation system is its strong research sector. Australia accounts for 3.71 per cent of the world's publications and 6.9 per cent of the world's one per cent most highly cited publications.[28]

2.16 The Department of Education and Training (DET) stated that human capital is 'a critical element in fostering and driving innovation'[29]. Australia has a relatively well educated population by OECD standards. The DIIS stated that in 2013, 39.5 per cent of Australians aged 25 to 64 had attained tertiary education above the OECD+ average of 33 per cent.[30] The DET also reported that 'since the early 1990s' the proportion of '20 to 64 years olds who hold a bachelor level qualification or higher increased three-fold, from around 10 per cent to 29 per cent.'[31]

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26 Chief Scientist for Australia (Chief Scientist), *Submission 49*, p. 2.

27 Dr James Chin Moody, Chief Executive Officer, Sendle, *Official Committee Hansard*, Sydney, 9 March 2016, p. 15.

28 University of Tasmania (UTAS), *Submission 34*, p. 1.

29 Department of Education and Training (DET), *Submission 40*, p. 5.

30 DIIS, *Australian Innovation System Report 2015*, p. 121.

31 DET, *Submission 40*, p. 5.

2.17 Universities Australia described Australia's cutting edge innovation and 'levels of research and development in our innovative firms' as 'underwhelming'.[32] Universities Australia explained that:

> The percentage of innovative firms in the manufacturing and services sectors that undertake R&D, either internally or with a partner, is the lowest and second lowest respectively in the OECD. In addition, only 9.3 per cent of large firms in Australia (27 of 28 OECD countries) and 9.2 per cent of SMEs (21 of 28) introduced products new to the market in the period 2010 to 2012.[33]

2.18 The University of Tasmania (UTAS) suggested that Australia's lack of corporate R&D facilities meant that universities had a greater responsibility to engage in knowledge diffusion. The UTAS stated:

> In considering mechanisms to promote innovation linkages it must be noted that Australia does not have the large corporate R&D base present in much of the US, UK , Europe and East Asia. This lack of technology-receptive avenues (ready to absorb and use knowledge produced in Australia's universities) necessitates a different knowledge diffusion and innovation model for Australia's circumstances. An Australian innovation model must address this difference and recognise that universities must take on more of the "heavy lifting" in the knowledge diffusion process.[34]

## Role of Innovation and Science Australia

2.19 As part of the NISA package the Government announced the creation of a new independent statutory body, Innovation and Science Australia (ISA), with responsibility for 'strategic whole of government advice on all science, research and innovation matters'.[35] The Government's investments in research and innovation are spread across 15 portfolios and ISA will assist with 'coordination of data and advice' to evaluate these measures and plan future innovation investments.[36]

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32 Universities Australia, *Submission 27*, p. 3.

33 Universities Australia, *Submission 27*, p. 3.

34 UTAS, *Submission 34*, pp 1–2.

35 Australian Government, *National Innovation and Science Agenda: Innovation and Science Australia*, http://www.innovation.gov.au/page/innovation-and-science-australia Accessed 19 April 2016.

36 NISA, *Factsheet 25, Innovation and Science Australia*.

2.20 The ISA will replace Innovation Australia but will have 'broader functions than its predecessor'.[37] The ISA's board will be 'chaired by the current Innovation Australia Board Chair Mr Bill Ferris AC and Australia's Chief Scientist will serve as Deputy Chair'.[38] The ISA is due to commence on 1 July 2016.[39]

2.21 The incoming Chair of the ISA stated that among the first tasks undertaken by ISA will be 'mapping the extant programs, state and federal—who is doing what'.[40] The Chief Scientist reported that following the assessment of existing programs the ISA will develop a 'national strategy plan for science, research and innovation to cover a 15-year period'.[41]

## Emerging Opportunities

2.22 Several universities believed that Australia had an opportunity to improve its research and innovation performance by focusing research on areas where Australia had a strong chance of developing world-leading research and innovation. The Australian Technology Network stated that universities should collaborate on 'genuine areas of excellence' to address 'grand challenges for individual industry sectors' and that this would 'strengthen Australia's global competitiveness'.[42]

2.23 La Trobe University called for 'prioritising government investment in industry sectors with high growth potential that align with historic areas of competitive advantage'.[43] La Trobe University added that the Industry Growth Centres and the National Science and Research Priorities should form a focus for future investment.[44]

2.24 Sendle also emphasised the importance of aligning research investment to Australia's competitive advantage, stating:

> Where does Australia want to make its mark internationally? Where are we aligning great competitive advantage—national competitive

37 Australian Government, *National Innovation and Science Agenda: Innovation and Science Australia*, http://www.innovation.gov.au/page/innovation-and-science-australia Accessed 19 April 2016.

38 DIIS, *Innovation and Science Australia*, http://www.industry.gov.au/Innovation-and-Science-Australia/Pages/default.aspx Accessed 19 April 2016.

39 DIIS, *Innovation and Science Australia*, http://www.industry.gov.au/Innovation-and-Science-Australia/Pages/default.aspx Accessed 19 April 2016.

40 Mr William Ferris, Chair, Innovation and Science Australia (ISA), DIIS, *Official Committee Hansard*, Canberra, 3 March 2016, p. 11.

41 Dr Alan Finkel, Chief Scientist, *Official Committee Hansard*, Canberra, 3 March 2016, p. 2.

42 Australian Technology Network, *Submission 46*, p. 1.

43 La Trobe University, *Submission 39*, p, 2.

44 La Trobe University, *Submission 39*, p, 2.

> advantage—with global megatrends? … If we can match them up we can confidentially start to stick some stakes in the ground and say, 'Yes, this is an area that we actually want to start focusing on as a country.'[45]

# Education — An Innovation Approach to Skills and Training

## Role of Universities and TAFES

2.25 Universities Australia advised that the economy is estimated in 2025 to require 'approximately 2.1 million more university graduates than it needed in 2015' which was equal to a 30 per cent demand growth. Skilled graduates would be required in 'education and training; healthcare and social assistance; professional, scientific and technical services; public administration and safety; and financial and insurance services.'[46]

2.26 Universities Australia added that international students currently helped to fill skills gaps in Australia's workforce. For example, former international students made up 'around one third of the skilled migrants to Australia in 2013–14.'[47]

2.27 Curtin University advised that the education 'trade' was one of Australia's top four export industries and was worth $18 billion in 2014–15. In addition, the direct and indirect revenue from international students was $140 billion for the same year. Curtin University added that 'major changes in policy settings on international education' in the last decade had diminished opportunities and allowed offshore competitor institutions to gain a greater market share. Further, while the market had recovered in the last three years, more needed to be done.[48]

2.28 Universities Australia stated that in 2014 university research had generated knowledge with an estimated value of $160 billion, 'equivalent to almost 10 per cent of Australia's gross domestic product.'[49]

2.29 The UTAS, however, reported that while Australia ranked well on the Global Innovation Index for innovation inputs,[50] it ranked much lower for innovation results.[51]

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45 Dr James Chin Moody, Sendle, *Official Committee Hansard*, Sydney, 9 March 2015, p. 16.

46 Universities Australia, *Submission 27*, p. 5.

47 Universities Australia, *Submission 27*, p. 6.

48 Curtin University, *Submission 20*, p. 2.

49 Universities Australia, *Submission 27*, p. 1.

50 7th globally on tertiary education, 8th on R&D, 9th on general infrastructure.

2.30 La Trobe University drew attention to the level of funding per student which had remained flat in real terms over 20 years and had constrained 'the degree to which universities balance high quality teaching and research with greater access.' La Trobe University acknowledged the need for budget repair, but stated:

> … maintaining insufficient rates per student funding undermines the role of higher education plays in skills development, research and innovation.[52]

2.31 TAFE Directors Australia commented that about 3.4 million people were enrolled in the vocational education sector[53] and this was 'probably three times larger than the university sector'. TAFEs enrolled about 1.6 million students a year including about 40 000 Chinese students.[54] TAFE Directors Australia also stated that course completions for TAFE students had increased in contrast to the overall trend for the vocational education sector. Ninety per cent of those who completed a TAFE course obtained employment because job experience was a component of TAFE courses.[55]

2.32 TAFE Directors Australia drew attention to the links between TAFE institutions and universities. Universities, particularly in regional areas, positioned their products or programs as a follow on from TAFE. For example, 'up to a third or more' of Charles Sturt University's graduate intake was from TAFE.[56]

## STEM Education

2.33 The Chief Scientist stated that the ability to deliver on the innovation agenda will always depend on having a highly skilled workforce. 'Young people and young adults [needed] to be deeply skilled and have disciplined knowledge.' The Chief Scientist, however, had 'serious concerns' about the diminishing capacity to provide the appropriate training. Not only was this becoming apparent in schools but 'also becoming significant in universities'.[57]

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51 26th for knowledge creation, 42nd for innovation linkages, 48th for knowledge absorption, 78th for knowledge diffusion. UTAS, *Submission 34*, p. 1.

52 La Trobe University, *Submission 39*, p. 3.

53 Mr Martin Riordan, Chief Executive Officer, TAFE Directors Australia, *Official Committee Hansard*, Sydney, 8 March 2016, p. 36.

54 Mr Martin Riordan, TAFE Directors Australia, *Official Committee Hansard*, Sydney, 8 March 2016, p. 34.

55 Mr Martin Riordan, TAFE Directors Australia, *Official Committee Hansard*, Sydney, 8 March 2016, p. 36.

56 Mr Martin Riordan, TAFE Directors Australia, *Official Committee Hansard*, Sydney, 8 March 2016, p. 37.

57 Dr Alan Finkel, Chief Scientist, *Official Committee Hansard*, Canberra, 3 March 2016, p. 1.

2.34 The problem was most apparent in the lower secondary schools where there were 'recognised problems, especially in the STEM disciplines'. This was:

> …due to too many teachers teaching out of field. That [was] either because they did not have a specialty to start with, because they have done an undergraduate education degree with no actual emphasis on specialisation, or because the school happens to be under pressure and is putting teachers into teaching maths in the lower secondary who are just were not trained at that. The problem is not very common in the upper secondary. The schools do tend to get skilled teachers into the upper secondary …[58]

2.35 A report prepared for the Australian Council of Learned Academies stated that Australia has high levels of participation in STEM subjects at the year 12 level (72 per cent maths, 52 per cent science).[59] At tertiary level, however, STEM student enrolments are comparatively low, particularly in engineering and mathematics.[60] Tertiary enrolments in information technology declined by 50 per cent between 2002 and 2010 but have risen slightly since.[61]

2.36 This has followed through to Australia's research capability which, the CSIRO stated, was very strong in a number of scientific disciplines, but was 'well below average' in a number of STEM disciplines such as engineering, physics, chemistry, materials science, and mathematics.[62] There was also a gender imbalance in the STEM fields.

2.37 The DIIS commented that a cultural change was necessary to achieve gender balance in STEM disciplines and stated:

> … women make up 55 per cent of STEM graduates but only one in four information technology graduates and less than one in 10 engineering graduates. They occupy fewer than one in five senior research positions in Australian universities and make up around a quarter of the STEM workforce overall.[63]

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58 Dr Alan Finkel, Chief Scientist, *Official Committee Hansard*, Canberra, 3 March 2016, p. 3.

59 Marginson, S, Tytler, R, Freeman, B and Roberts, K, *STEM: Country comparisons*. Report for the Australian Council of Learned Academies, 2013, p. 61

60 Marginson, S, Tytler, R, Freeman, B and Roberts, K, *STEM: Country comparisons*. Report for the Australian Council of Learned Academies, 2013, p. 61

61 Bell, J, Frater, B, Butterfield, L, Cunningham, S, Dodgson, M, Fox, K, Spurling, T, and Webster, E, *The role of science, research and technology in lifting Australian productivity*, Australian Council of learned Academies, 2014, p. 94.

62 Mr Craig Rawley, Deputy Chief Executive, CSIRO, *Official Committee Hansard*, Canberra, 3 March 2016, p. 12.

63 Mrs Jane Urquhart, Head, Science and Commercialisation Policy Division, DIIS, *Official Committee Hansard*, Canberra, 25 February 2016, p. 7.

2.38 The NISA includes an initiative aimed at inspiring Australians, 'from pre-schoolers to the broader community' to engage with 'STEM in society and participate in further study.' The measures include:

- expanding the Prime Minister's Prizes for Science;
- supporting students to participate in international STEM-based competitions and hosting the 2019 Asian Physics Olympiad;
- developing 'play-based learning apps and science and mathematics resources for early childhood educators'; and
- 'expanding community engagement, including Inspiring Australia and citizen science projects.'[64]

2.39 The NISA also includes an initiative to 'encourage more women to embark on, and remain in,' STEM related careers. The initiative includes:

- expanding the Science in Australia Gender Equity pilot;
- establishing a new initiative to focus on STEM-based and entrepreneurial industries; and
- partnering with the private sector on initiatives to promote female STEM role models and foster interest in STEM.[65]

2.40 The University of Technology Sydney stated that expanding a STEM-skilled workforce was only part of the solution. Other 'boundary crossing skills' were needed such as creativity and problem solving.[66] Cloud Insurance P/L commented that an emphasis on STEM programs and young people, missed 'a whole populace of 50-plus who have gone through maybe different machinations of technology and systems in their lifetimes that will play a vital role in our economy's future.' Encouraging workers over the age of 50 back into the workforce would bring experience of due diligence processes and financial services to the FinTech sector.[67]

## Other Innovation Skills

2.41 The University of South Australia reported that innovative research often challenges academic discipline boundaries stating 'disruptive innovation, which can include transformational technologies, are often derived from

64 NISA, *Factsheet 18, Inspiring a Nation of Scientists.*

65 NISA, *Factsheet 20, Expanding Opportunities for Women in Science, Technology, Engineering and Mathematics.*

66 Professor Roy Green, Dean, UTS Business School, University of Technology Sydney, *Official Committee Hansard*, Sydney, 9 March 2016, p. 29.

67 Ms Joanne Cooper, Director, Cloud Insurance P/L, *Official Committee Hansard*, Sydney, 8 March 2016, p. 41.

research occurring at the boundaries of individual disciplines'.[68] In a similar vein, the University of Wollongong emphasised the importance of interdisciplinary research, which it had supported from its 'very earliest days', stating:

> This is in recognition of the fact that, in the modern era, we must be interdisciplinary if we are to find solutions to modern problems. In the same way that problems tend to occur at the intersection of disciplines, their solutions can be found there too.[69]

2.42 The Australian Academy of Humanities (AAH) emphasised that 'in a global age, innovation will be underpinned by language proficiency and inter-cultural competence. These knowledge sets and skills must be recognised as core competencies of the innovation system.'[70] The AAH also stated that the humanities, arts and social sciences have 'a massive contribution to make to an ideas-driven agenda for Australian innovation' and that Australia's innovation system will require 'workforces that encourage the dynamic interaction of technical and non-technical skills.'[71]

2.43 The Chief Scientist stated that 'STEM R&D is necessary but not sufficient to grow a strong knowledge economy; an entrepreneurial mindset is required to utilise STEM knowledge for innovation.'[72] The Chief Scientist further stated that 'entrepreneurship has been part of university education in the USA for over three decades' but that, by contrast, 'Australian universities do not place a priority on teaching high-impact entrepreneurship, and there are no funding incentives to engage in entrepreneurial behaviour or teaching'.[73]

# Early Stage Research

## Funding Public Sector Research

2.44 The DET described Australia's current system of research funding through the Australian Research Council (ARC). The National Competitive Grants Program supported both basic research as well as applied research and sought to balance the research to:

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68 University of South Australia, *Submission 9*, p. 3.

69 Mr Paul Scully, Chief Operating Officer, Australian Institute for Innovative Materials, University of Wollongong, *Official Committee Hansard*, Sydney, 9 March 2016, p. 9.

70 Australian Academy of the Humanities, *Submission 33*, p. 3.

71 Australian Academy of the Humanities, *Submission 33*, p. 3.

72 Chief Scientist, *Submission 49*, p. 3.

73 Chief Scientist, *Submission 49*, p. 3.

> … find the big discoveries of today that will help to make our industries innovative and more competitive now but also research which will benefit our community, environment and industries in the years to come.[74]

2.45 Block grants, which are not tied to specific projects, are provided to universities allocated on a competitive peer review process. The DET advised that new arrangements would be introduced for 2017 which would 'boost reward for industry and other end-user engagement, giving it equal emphasis to research quality.'[75] The new arrangements are part of the NISA.[76]

2.46 The ARC also funds Linkage Projects which are used for solving problems that 'help generate more products and services for Australia's economic, commercial and social benefit.'[77]

2.47 The University of Melbourne commented that the block grant funding scheme would specifically reward collaboration with industry, but suggested that international experience had shown that a dedicated funding stream could also act as an effective stimulant for collaboration. The University of Melbourne recommended that this new third stream of funding be introduced, but that it should not come at the expense of the value of current block grants.[78]

2.48 Curtin University was concerned that the continual changes to programs designed to assist commercialisation and a low funding commitment to those programs had limited their effectiveness.[79] The University of South Australia was similarly concerned.[80]

2.49 The Australian Nuclear Science and Technology Organisation (ANSTO) reported that it was 'not eligible to directly apply for linkage grants from the ARC (and the NHMRC). If this was changed ANSTO could extend and better support industry'.[81]

2.50 The increased focus on commercialisation in the NISA was welcomed by the University of Melbourne. The University, however, advocated for complementary actions to address the early stages of the translation of ideas to commercialisation:

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74 DET, *Submission 40*, p. 8.

75 DET, *Submission 40*, p. 8.

76 NISA, *Factsheet 11, Driving Greater Collaboration through University Research Block Grants.*

77 DET, *Submission 40*, p. 9.

78 University of Melbourne, *Submission 41*, pp 16, 17.

79 Curtin University, *Submission 20*, p. 6.

80 University of South Australia, *Submission 9*, p. 3.

81 Australian Nuclear Science and Technology Organisation, *Submission 7*, p. 6.

> Provision of support at the very early stage is critical to building a flowing source of potential commercialisation ventures that can go on to bid for seed and venture capital funding.
>
> The translation gap will *not* be filled by the market as the nature of the endeavour means that most of these opportunities will never make a commercial return.[82]

2.51 The University of Newcastle stated that while the NHMRC provided proof-of-concept funding for health and medical research there was no similar scheme under the ARC. The lack of proof-of-concept funding made it difficult to progress research outcomes to a commercialisation stage.[83]

2.52 Sendle categorised research into Horizon 1, 2, and 3 research and suggested that Australia was not undertaking enough Horizon 2 research. Sendle stated:

> Horizon 1 is where you have known knowledge and known application. Horizon 2 is known application but unknown knowledge—that is where we know the problem and we need to do research. That is often where a CSIRO or others fit in. Horizon 3 is unknown knowledge and unknown application—that is what is sometimes called 'basic research'… I think we probably need a bit more balance in horizon 2… I think a good innovation system is a bit of a normal curve around horizon 2… my big questions would be around ARC [is] 'are we getting that balance right?'[84]

2.53 Industry funding for university research totalled $1.59 billion for the three years 2008 to 2010. Medical and Health Sciences received 44 per cent of this funding ($700 million), with Engineering ($220 million) and Biological Sciences also receiving significant shares ($150 million).[85] Explaining the proportion of funding going to Medical research, Professor Roy Green stated that:

> The concentration of funding in the medical and health sciences reflects the strong and continuous investments over many decades in basic, or fundamental research through the NHMRC, State governments, philanthropy and other sources. It has built up a

82 University of Melbourne, *Submission 41*, p. 13.

83 University of Newcastle, *Submission 10*, p. 8.

84 Dr James Chin Moody, Sendle, *Official Committee Hansard*, Sydney, 9 March 2016, p. 16.

85 Professor Roy Green, *Exhibit 5: Australia's Innovation Future: Committee Expert Consultant Report for Senate Economics References Committee's Inquiry into Australia's Innovation System*, p. 25.

> world-class capability that is of interest to the health and medical industry.[86]

## National Health and Medical Research Council Development Grants

2.54 The NHMRC stated that its Development Grants were specifically designed to support 'proof-of-principle or pre-seed research to help bring discoveries to the point where they can attract commercial funding.'[87] The Development Grants scheme:

> … supports the commercial development of a product, process, procedure or service that if applied, would result in improved health care, disease prevention or provide health cost savings.
>
> Research supported by this scheme must have experimental data that supports a demonstrated proof of principle or pre-seed concept and have a detailed feasible commercialisation strategy that takes into account the regulatory pathway, protectable IP, commercial barriers and potential routes to market.[88]

2.55 The NHMRC stated that the grants were attempting to bridge 'at least the first part of the so-called 'valley of death'[89] before venture capital funding and other sources of commercial funding can take over.'[90]

## Biomedical Translation Fund

2.56 The Biomedical Translation Fund will be managed by an 'independent body that will invest in promising biomedical discoveries and assist in their commercialisation.' The Biomedical Translation Fund will draw on private sector fund managers who 'will bring at least matching funding'. The $250 million fund will be 'funded by reducing the capital

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86 Professor Roy Green, *Exhibit 5: Australia's Innovation Future: Committee Expert Consultant Report for Senate Economics References Committee's Inquiry into Australia's Innovation System*, p. 25.

87 Professor Anne Kelso AO, Chief Executive Officer, National Health and Medical Research Council (NHMRC) *Official Committee Hansard*, Canberra, 17 March 2016, p. 1.

88 NHMRC, *Development Grants*, https://www.nhmrc.gov.au/grants-funding/apply-funding/development-grants Accessed 12 April 2016

89 The 'valley of death' is a period in the development of an innovation where the innovator faces significant costs but minimal opportunities to earn revenue. The CSIRO explained that 'the Valley of Death is identified as a phase of commercialisation before 'success as a business' where there is little to no income and a large outgoing cash flow. Often this phase is after a period where there has already been significant investment in R&D and resources may be depleted.' CSIRO, *Submission 43*, p. 6.

90 Professor Anne Kelso AO, *Official Committee Hansard*, Canberra, 17 March 2016, p. 1.

contributions to the Medical Research Future Fund' and will be 'fully capitalised by 2019–20.'[91]

2.57 The ISA observed that having 'private sector funds managers with experience and scar tissue in backing medical discoveries and commercialising them' will be attractive to small business and their boards.[92]

2.58 CSL Ltd supported the Biomedical Translation Fund and advised that it had formally submitted to the Government that 20 percent of the Medical Research Future Fund be directed towards such translational research when the future fund was fully operational because it was 'a fundamental economic driver for the country and something that is missing at the moment.'[93]

### CSIRO Innovation Fund

2.59 The CSIRO Innovation Fund was established under the NISA and will include a $200 million early stage innovation fund. This fund will 'support co-investment in new spin-off and start-up companies, products and services created by Australian research institutions.' The CSIRO Innovation Fund will be funded in part by revenue from licensing CSIRO's wireless local area network technology, and investment from the private sector. The fund will commence in 2016 with oversight from the CSIRO Board.[94]

## Basic Research

2.60 Several organisations emphasised the importance of basic (also known as pure or foundational) research in enabling the long-term development of innovation. The AAS stated that:

> Basic research is the genesis of all innovation in that it is the new discoveries and leaps in understanding that provide the human and knowledge capital to drive innovative solutions to current and future challenges. Unless Australia maintains its capacity to undertake world-class basic research across diverse fields of science, there will be a diminished capacity to engage in and enjoy the benefits of innovation in the future.[95]

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91 NISA, *Factsheet 6, Biomedical Translation Fund.*

92 Mr William Ferris, ISA, *Official Committee Hansard*, Canberra, 3 March 2016, p. 9.

93 Dr Andrew Cuthbertson, Chief Scientific Officer and R&D Director, CSL Ltd, *Official Committee Hansard*, Melbourne, 10 March 2016, p. 8.

94 NISA, *Factsheet 5, CSIRO Innovation Fund.*

95 AAS, *Submission 3*, p. 10.

2.61 The AAS further highlighted that future commercial output is only one of the benefits that basic research provided to society and provided examples of other benefits such as:

- improvements in public health through new or improved methods of clinical practice, based on advances in biomedical knowledge;
- advances in management of land and the environment through improved knowledge of natural processes; and
- production of graduates trained in research techniques and methods, who use their skills in the public and private sectors to solve difficult problems that face the community.[96]

2.62 The University of Newcastle also supported the value of basic research and emphasised its critical role in ensuring the long-term health of Australia's innovation system, and stated that:

> It is vital that the importance of basic research is not ignored or downplayed. Without the underpinning activities of basic research the commercialisation processes will very quickly drain the well of innovation leaving nothing to commercialise.[97]

## Research Collaboration

2.63 One of the key weaknesses in the Australian innovation system is the low level of collaboration between public sector research organisations and the private sector. The *Australian Innovation System Report 2015* reported that Australian innovation-active small to medium sized enterprises (SME) ranked 24th in the OECD[98] and innovation-active large businesses, 29th in the OECD, in relation to collaborating on innovation.[99]

2.64 The DIIS, emphasised the importance of collaboration between research and business and stated:

> Links between research organisations and businesses are crucial in order to diffuse knowledge and commercialise research. Research collaboration is also fundamental to scientific excellence and technological breakthroughs.[100]

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96 AAS, *Submission 3*, p. 10.

97 University of Newcastle, *Submission 10*, p. 8.

98 Of 31 countries measured which included all members of the OECD as well as China, Taiwan and Singapore.

99 DIIS, *Australian Innovation System Report 2015*, p. 115.

100 DIIS, *Submission 31*, p. 2.

2.65 The DET also highlighted the critical importance of collaboration in yielding commercial benefits from research and supporting Australia to meet economic and social challenges, and stated that:

> Greater collaboration between the research and innovation sector and industry is critical if the research and innovation taking place in Australia are to yield commercial outcomes. This is an essential step in ensuring that research and innovation support Australia to meet its current and future geographic, economic and labour challenges.[101]

2.66 The University of Newcastle emphasised that in knowledge based economies successful innovation systems required collaboration. The University of Newcastle stated:

> In the context of a knowledge-based economy, however, the research sector cannot operate effectively in isolation. The best innovation systems are those where new industries and opportunities are delivered through collaboration across research, industry and government. Each of the key stakeholders has an important role to play in maximising Australia's strengths and driving innovation.[102]

## Encouraging Public Sector Demand for Collaboration

### Incentives for Universities and Academics

2.67 One of the most significant barriers to greater collaboration between universities and industry are the metrics used to evaluate the performance of universities and their staff.

2.68 Victoria University explained how the Excellence in Research for Australia (ERA) program created a barrier to universities engaging with industry Victoria University explained:

> … the Commonwealth's ERA initiative 'rewards' research excellence by measuring it according to traditional academic metrics, including publication in top-ranking academic journals. On the other hand, activities that have a direct impact on industry, government and community clients, especially those that provide a commercial return, do not achieve results in terms of ERA recognition. As a consequence, in the pursuit of ERA recognition,

101 DET, *Submission 40*, p. 4.

102 University of Newcastle, *Submission 10*, p. 2.

> researchers avoid many forms of industry collaboration, presenting implications for and coming at a cost to innovation.[103]

2.69 Australia's Chief Scientist explained that in addition to the ERA rankings, international university ranking systems also place pressure on universities and academics to prioritise publications, stating that these ranking systems are all:

> … based on research excellence through publications and citations. Because Australian universities absolutely depend on international students, and because international students in coming here depend in turn on how well Australian universities are ranked internationally, there is this drive towards publications and citations. That means for an average academic that, if you take six months working with a company—even if it is well funded—you do not get any publications during those six months. That is a problem for you personally and it is a problem for your department.[104]

2.70 Macquarie University stated that publications are 'really paramount in getting people promoted'.[105] Macquarie University also highlighted the 'structural promotion of publication over patenting', suggesting this was 'counterintuitive', and that there should be 'equality in recognition and reward for these activities.'[106]

2.71 The NISA package includes two important measures which are: the changes to university research block grants, and the introduction of an impact and engagement measure. Both aim to reform financial and reputational incentives for universities and academics.[107]

2.72 The reforms to the university research block grants will introduce new 'funding arrangements for universities that will give equal emphasis to success in industry and other end-user engagement and to research quality'.[108] The DET explained the significance of this change and stated:

> … changes to the research block grant system have given greater weight to what we call category 2 and category 3 research income,

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103 Victoria University, *Submission 19*, p. 3.

104 Dr Alan Finkel, Chief Scientist, *Official Committee Hansard*, Canberra, 3 March 2016, p. 5.

105 Professor Lesley Hughes, Pro-Vice Chancellor, Research Integrity and Development, and Distinguished Professor of Biological Sciences, Macquarie University, *Official Committee Hansard*, Sydney, 9 March 2016, p. 48.

106 Macquarie University, *Submission 18*, p. 4.

107 Ms Jessie Borthwick, Acting Deputy Secretary, Higher Education, Research and International Cluster, DET, *Official Committee Hansard*, Canberra, 25 February 2016, p. 10.

108 NISA, *Factsheet 11, Driving Greater Collaboration through University Research Block Grants.*

> which is income that universities earn from other sources outside of the competitive grants system—industry-commissioned work, work for state governments and their instrumentalities and that sort of activity. The weight of that in the formulas has been evened up with the competitive funding sources, so the weighting now is fifty-fifty between those two types of money that drive the research support program, which is the main research block grant for enabling the universities to create research capacity in their institutions.[109]

2.73 The Government is developing a measure of 'non-academic impact and industry and end-user engagement' for university research.[110] The ARC and the DET are co-chairing two working groups developing the impact and engagement indicators.[111] The indicators will be developed, in consultation with universities, during 2016. A pilot assessment will take place in 2017 and full national assessment and reporting will begin in 2018.[112]

2.74 The DET stated that at this stage the impact and engagement measurements would be a reputational rather than financial incentive. The DET explained the rationale for not yet linking funding decisions to these measurements. The DET stated:

> At this point it is just reputational. The funding side is quite potent already. When the new impact of engagement measure was developed we foreshadowed in the innovation statement announcements that we would reconsider the funding formulas to see whether or not the new measure should be brought in. But, I have to say, it would be pretty cavalier of us to announce a new measure coming into the funding system without actually having seen that measure and how it performs over time. So, we do need to do some work to prove the measure up before attaching funding to it.[113]

2.75 The need to reform incentives so that engaging in collaborative projects with industry was not detrimental to academics' career progression was widely supported across the university sector. For example, the University of Wollongong stated that 'improved incentives for university researchers

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109 Mr Dominic English, Group Manager, Research and Economic Group, DET, *Official Committee Hansard*, Canberra, 25 February 2016, p. 10.

110 NISA, *Factsheet 16, Measuring Impact and Engagement in University Research.*

111 Australian Research Council, Research Engagement and Impact Working Groups Announced, *Media Release*, http://www.arc.gov.au/news-media/media-releases/research-engagement-and-impact-working-groups-announced Accessed 19 April 2016.

112 NISA, *Factsheet 16, Measuring Impact and Engagement in University Research.*

113 Mr English, DET, *Official Committee Hansard*, Canberra, 25 February 2016, p. 11.

to engage with industry would greatly boost collaboration'.[114] The University of Melbourne recommended Government 'support universities to create stronger internal incentives and rewards structures for academic researchers to build engagement with end-users and strengthen impact.'[115]

2.76 The AAS, however, was concerned that the development of metrics to measure research impact outlined in the NISA could result in a 'bias against basic research'. While noting that the impact metrics were yet to be developed, the AAS stated:

> … it is likely to be based on existing work which uses research income as a proxy for engagement, so that engagement is only considered where money changes hands. This cannot take into account those situations where academic researchers work with other organisations collaboratively to solve problems which may not have an immediate commercial aspect. In addition, should the research engagement metric be tied to incentives, it is likely that non-commercial but publicly beneficial research would be discouraged.[116]

2.77 The AAS supported the current method of evaluating research based on the ERA framework, and stated:

> The most appropriate assessment of university research is its quality. The ERA process remains the most suitable way to evaluate Australian research effort, and policy decisions should be based on these data. Importantly, the ERA is an appropriate way to assess both basic and applied research.[117]

## Researcher Mobility

2.78 The CSIRO highlighted that only 30 per cent of Australia's research workforce is employed by industry, 'which is very low by OECD standards, and compares particularly poorly with innovation powerhouses US and Japan who have almost 80 per cent of their R&D workforce in industry'.[118] The small proportion of researchers employed by industry constrains the ability of Australian business to undertake research and also limits the opportunities for business to collaborate with research organisations to commercialise research outcomes.[119]

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114 University of Wollongong, *Submission 5*, p. 5.

115 University of Melbourne, *Submission 41*, p. 5.

116 AAS, *Submission 3*, p. 10.

117 AAS, *Submission 3*, p. 11.

118 CSIRO, *Submission 43*, p. 4.

119 CSIRO, *Submission 43*, p. 4.

2.79 The limitations created by the small proportion of researchers working in industry are exacerbated by the barriers that researchers face when considering moving between academia and industry during the course of their career.

2.80 The Chief Scientist compared the opportunities for academics in Australia and in the United States who spend a period of their career working in industry, the Chief Scientist stated:

> If you are a researcher at Stanford University and you want to go and spend three years with a start-up or an established company and you do well, you are welcomed back into the academic community at Stanford University three or five years later. Whereas a typical academic who does that from an Australian university would struggle to get back because they would have a gap in their publication record, which is considered to put at risk their ability to get the next grant.[120]

2.81 Western Sydney University (WSU) supported greater mobility for researchers to move between industry and the university sector stating 'industry and university interactions should be fluid, involving not just commercial transfer but the regular exchange of people and the creation of knowledge spill-overs.'[121] The WSU also provided a number of examples of measures that could increase mobility that included work integrated learning programs for undergraduates, 'industry-based sabbaticals for academics, university research placements for those working in industry, and industry co-supervision of PhD students.'[122]

2.82 The concept of industry sabbaticals was also supported by the University of Wollongong which suggested the sabbaticals could involve a half-year placement with industry funded through a competitive grants process.[123] The University of Melbourne reported that it was in the process of implementing an industry sabbaticals program.[124]

2.83 A number of universities supported greater engagement of PhD students with industry, either through placements or industry supervision. For example, the University of Melbourne saw potential for 'embedding PhD candidates within new and innovating enterprises as a means to facilitate access to high-quality research while providing industry relevant skills to researchers.'[125] The University of South Australia reported that it had

120 Dr Alan Finkel, Chief Scientist, *Official Committee Hansard*, Canberra, 3 March 2016, p. 5.

121 Western Sydney University (WSU), *Submission 23*, p. 7.

122 WSU, *Submission 23*, p. 7.

123 University of Wollongong, *Submission 5*, p. 4.

124 University of Melbourne, *Submission 41*, p. 9.

125 University of Melbourne, *Submission 41*, p. 16.

identified the need for a 'transformed' PhD that would be 'centred on increasing graduate researchers' capabilities to work collaboratively and productively with end-users, and in multidisciplinary and multi-sectoral research ventures.'[126]

2.84 The Regional Universities Network recommended the establishment of a programme of industry PhD scholarships, 'focussing on SMEs and non-commercial partners, to be jointly funded by universities and partner organisations'. The Regional Universities Network also suggested that 'favourable taxation treatment' could be available to industry as an incentive to fund the scholarships.[127]

2.85 The University of South Australia recommended that the limited opportunities for researchers to move between the university sector and industry during the course of their career should be addressed by the development of a national initiative 'to encourage greater fluidity of employment between industry and academia'.[128]

## Encouraging Business Demand for Collaboration

2.86 The ISA was pleased that many universities were actively promoting their business development activities. The ISA was less confident about the level of movement from business to engage with universities in research collaborations.[129]

2.87 Western Sydney University highlighted the low demand for university research by Australian with only '3.1 per cent of Australian businesses [identifying] universities as a source of ideas or information about their business.'[130]

2.88 The AAS suggested that limited desire for business-university partnerships was a key barrier to improving industry-university collaboration in Australia. The AAS stated:

> Engagement between industry and universities is most likely where a business wishes to innovate… It is likely that the main factors impeding greater overall levels of collaboration between universities and industry are a lack of desire among business

126 University of South Australia, *Submission* 9, p. 5.

127 Regional Universities Network, *Submission 11*, p. 5.

128 University of South Australia, *Submission 9*, p. 1.

129 Mr William Ferris, ISA, *Official Committee Hansard*, Canberra, 3 March 2016, p. 7.

130 Western Sydney University, *Submission 23*, p. 3.

> owners to engage innovative expertise available in Australian universities, or a lack of means and incentives for them to do so.[131]

2.89 The AAS further stated that amongst Australian businesses 'between 75 and 92 per cent of innovations were new-to-firm only'.[132] The AAS suggested that 'low demand from Australian innovators for new knowledge to drive new-to-world products and services' was a root cause of low levels of collaboration and commercial benefits from research and that 'it is important to stimulate demand amongst Australian business for research expertise'.[133]

2.90 Universities Australia stated that 'despite considerable investment by the Australian Government…Australian businesses tend not to pursue innovation as a priority'.[134] Latrobe University suggested that business demand for collaboration was not increasing despite government support for business R&D stating 'the massive increase in government outlays associated with the R&D tax incentive are not translating to an increase in university income, so something is happening there which needs to be fixed'.[135]

2.91 Victoria University suggested many government programs to foster collaboration may be 'considered beyond reach by many small to medium sized enterprises (SMEs), assuming they are aware of the programs existence in the first place.'[136]

2.92 The University of South Australia supported the development of collaboration models that were more appropriate for SMEs, and stated:

> Additional funding schemes that support exploratory pilot projects, fast start, short review timelines, would be beneficial to SMEs that are looking to work with research institutions to develop disruptive technologies and solve pressing problems.[137]

131 AAS, *Submission 3*, p. 7.

132 AAS, *Submission 3*, p. 8.

133 AAS, *Submission 3*, p. 8.

134 Universities Australia, *Submission 27*, p. 3.

135 Mr Matthew Brett, Senior Manager, Higher Education Policy, La Trobe University, *Official Committee Hansard*, Melbourne, 10 March 2016, p. 37.

136 Victoria University, *Submission 19*, p. 5.

137 University of South Australia, *Submission 9*, p. 4.

# Successful Examples of Collaboration

## Overseas Examples

2.93 Examples of university-business collaboration in overseas countries include:

- The Dutch Top Sectors Policy—includes a platform where industry and academia meet and negotiate co-investment in targeted research areas;[138]
- The UK Knowledge Transfer Partnerships—facilitates industry employing research graduates and allows access to the expertise of a graduate's supervisor;[139]
- SPARK Stanford—a partnership between university, health care services and industry aimed at: advancing promising research discoveries to the clinic and commercial sector; innovating efficient and cost-effective approaches to drug discovery and development; providing access to specialised knowledge and technical expertise; and supporting translational efforts to deliver products and services for unmet health needs;[140] and
- Canada's Waterloo University community-based research and technology park—a partnership including the University, local, State and Federal governments which provides an innovation hub focused on connecting university and researchers.[141]

2.94 Australia's Chief Scientist compared the work of Israel's Chief Scientist in supporting innovation and explained that their roles were different. In Israel, the Chief Scientist advanced economic translation through allocating competitive grants to early-stage businesses. In Australia, the Chief Scientist's role was to promote underlying science research through providing advice to government and to forums across the breadth of science research endeavour.[142]

## Australian Examples

2.95 Examples of collaboration between universities and business in Australia includes:

138 University of Wollongong, *Submission 5*, p. 7.

139 University of South Australia, *Submission 9*, p. 3.

140 Medical Technology Association of Australia, *Submission 32*, p. 3.

141 University of Newcastle, *Submission 10*, p. 3.

142 Dr Alan Finkel, Chief Scientist, *Official Committee Hansard*, Canberra, 3 March 2016, p. 4.

- The Newcastle Institute for Energy and Resources—the collaboration of industry and academia which provides access to large-scale test bed and pilot plant operations in the area of energy and resources;[143] and
- The Southern Manufacturing Innovation Group—comprises the University of Wollongong and 13 Illawarra based manufacturers where industry discussed their innovation processes and challenges, and the University presented information on its research and advanced materials and robotics.[144]

2.96 The Australian Nuclear Science and Technology Organisation (ANSTO) manages a number of Australia's major research infrastructure facilities. These facilities are made available to academic and industry researchers and ANSTO reported that 'in the last financial year alone, the OPAL research reactor, the Australian Synchrotron and the Australian Centre for Accelerator Science attracted approximately 5000 Australian and international researcher and industry visits and supported 1500 experiments.'[145]

## Public Sector Commercialisation Strategies

### Development of In-house Innovations

2.97 The CSIRO described how it recently selected potential commercial opportunities from its research. The CSIRO sought ideas from its staff which resulted in the generation of 200 ideas. These were assessed by a panel of CSIRO people and successful entrepreneurs and reduced down to 80 ideas. The number was shortlisted to 20 which were subjected to two to three days of testing. Nine teams resulted and the CSIRO 'took them off-line through a program for the order of about 12 weeks to rigorously road-test the ideas … and whether they could be new business opportunities.'[146]

2.98 The University of Melbourne has a similar process—a venture catalyst model—for commercialisation of its research. The University's business and development people would identify the most prospective

143 University of Newcastle, *Submission 10*, p. 3; Newcastle Institute for Energy and Resources, *About Us*, https://www.newcastle.edu.au/research-and-innovation/centre/nier/about-us Accessed 19 April 2016.

144 University of Wollongong, *Submission 5*, p. 2.

145 Dr Adrian Paterson, Chief Executive Officer, Australian Nuclear Science and Technology Organisation, *Official Committee Hansard*, Sydney, 8 March 2016, p, 52.

146 Mr Craig Roy, Deputy Chief Executive, CSIRO, *Official Committee Hansard*, Canberra, 3 March 2016, p. 14.

opportunities and put together a founding management team.[147] The University added:

> Initially you would put relatively modest funds in—it might be $200 000 or $300 000—designed around a proof of concept, proof of principle, and depending on the nature of the invention prototyping. Essentially what you are trying to do is put in enough money to enable the catalyst management to start to prove out and package that opportunity.[148]

2.99 Depending on its contribution, the university would own 10 or 20 per cent of the company of which the inventor would own 30 per cent.[149]

## Collaboration with Business

2.100 The University of Melbourne has a second avenue to commercialise its research through collaboration with CSL Ltd. CSL Ltd stated that it was 'doubling the size of [its] commitment to the University of Melbourne and the Parkville medical research institutes and hospitals' by increasing the number of scientists in the Bio21 Institute from 70 to 150. The Bio21 Institute would become CSL Ltd's 'global centre for research and translational medicine.'[150]

2.101 Deakin University also has a strong relationship with an industry sector. While motor car manufacturing by the Ford Motor Company is closing, Ford's R&D activities remain in Geelong. Currently, Deakin University has seven projects funded by Ford and is attracting overseas funds through this relationship.[151]

2.102 Deakin University's Geelong Innovation Precinct comprises research facilities, co-located industry partners including 'a number of early-stage spinouts … located adjacent to fibre processing and laboratory facilities.'[152]

2.103 One of the businesses is Carbon Revolution which 'started as a student project with a lecturer.' The company makes one-piece carbon fibre wheels

147 Mr Doron Ben-Meir, Executive Director Research, Innovation and Commercialisation, University of Melbourne, *Official Committee Hansard*, Melbourne, 10 March 2016, p. 55.

148 Mr Doron Ben-Meir, University of Melbourne, *Official Committee Hansard*, Melbourne, 10 March 2016, p. 56.

149 Mr Doron Ben-Meir, University of Melbourne and Professor James McCluskey, Deputy Vice-Chancellor, Research, University of Melbourne, *Official Committee Hansard*, Melbourne, 10 March 2016, p. 56.

150 Dr Andrew Cuthbertson, Chief Scientific Officer and R&D Director, CSL Ltd, *Official Committee Hansard*, Melbourne, 10 March 2016, pp 9, 10.

151 Professor Peter Hodgson, Deputy Vice-Chancellor Research Interim, Deakin University, *Official Committee Hansard*, Melbourne, 10 March 2016, p. 50.

152 Deakin University, *Submission 35*, p. 2.

and employs 200 people.[153] Carbon fibre composite manufacturer Quickstep Holdings has recently decided to establish its Automotive Division and global research and development centre at the Geelong Innovation Precinct.[154]

2.104 The Geelong Innovation Precinct is also the site of the Centre for Advanced Design in Engineering Training (CADET). Deakin University stated that CADET was:

> … a fulcrum for small to medium enterprise (SME) engagement via the Industry Innovation Program (IIP) managed by the Geelong Manufacturing Council (GMC). The IIP is a vehicle to identify specific research and development projects of relevance to GMC members and match these two engineering research groups, including students, building small-scale innovation into the SME community.[155]

2.105 Final year CADET students will be encouraged through 'innovation and entrepreneurship programs' to start 'their own companies as well as taking their ideas to market.'[156]

## Incubators and Accelerators

2.106 Deakin University is also building a manufacturing incubator and accelerator to support the increased industry involvement. This will support 150 innovation and entrepreneurial positions.[157]

2.107 Both Macquarie University[158] and La Trobe University[159] advised they too were moving towards establishing incubator and accelerator frameworks.

2.108 Curtin University drew attention to its Curtin Accelerate program which provides 10 week structured mentoring to students, staff and alumni who have an innovative business idea. Selection was 'extremely competitive' and successful applicants received a $5000 equity free grant, access to co-

153 Professor Peter Hodgson, *Official Committee Hansard*, Melbourne, 10 March 2016, p. 48.

154 Deakin University, *Quickstep brings global R&D to Geelong – Deakin's 'carbon cluster' will gain a major boost with Quickstep's high tech centre.* https://www.deakin.edu.au/research/story?story_id=2015/08/10/quickstep-brings-global-rd-to-geelong Accessed 11 April 2016.

155 Deakin University, *Submission 35*, p. 2.

156 Professor Peter Hodgson, *Official Committee Hansard*, Melbourne, 10 March 2016, p. 48.

157 Deakin University, *Submission 35*, p. 2.

158 Professor Lesley Hughes, Pro-Vice-Chancellor, Research Integrity and Development, Macquarie University, *Official Committee Hansard*, Sydney, 9 March 2016, p. 50.

159 Mr Matthew Brett, La Trobe University *Official Committee Hansard*, Melbourne, 10 March 2016, p. 38.

working space and facilities, and networks including commercialisation experts, investors and potential partners.[160]

2.109 The University of Wollongong advised that it had 29 start-ups on its innovation campus. In late 2016 the university will open its iAccelerate building which will provide 'space for up to 280 start-ups.' The start-ups will be provided with advice on business planning, legal and financial matters, and on marketing from 'local entrepreneurs and experts'. The university has also established an early-stage venture capital fund which will invest in iAccelerate start-ups. Start-ups which received funding will have to commit to maintaining a presence in the Illawarra region when they leave the iAccelerate incubator.[161]

2.110 The University of Melbourne also has a well-established start up incubator program, the Melbourne Accelerator Program. University of Melbourne stated:

> … in 2012 we provided four companies with $20 000, office space and mentoring. The whole idea there was to give young entrepreneurs an opportunity to test out a business idea in a fail-safe environment. …
>
> … our program has evolved to include a range of pre-accelerator activities designed to help upskill and, really importantly, connect aspiring entrepreneurs. Last year alone we had over 5000 people attend those events. We have also continued to increase the intake size of our accelerator program. This year we will have 10 start-ups come through …[162]

2.111 Potential start-ups were selected by a panel of 'venture capitalists and successful angel investors' from the university's 'mentor and advisory board network.' The criteria used included whether the proposal involved groundbreaking technology, whether the proponents could 'execute upon their vision',[163] and whether they could explain the business to the selection panel:

> If you are judging an entrepreneur in building a business … and they cannot explain it to you, they have a problem, not you. … Part of them running a business is the capacity to explain it to people who are not necessarily deep in their domain.[164]

160 Curtin University, *Submission 20*, p. 4.

161 Mr Paul Scully, Chief Operating Officer, Australian Institute for Innovative Materials, University of Wollongong, *Official Committee Hansard*, Sydney, 9 March 2016, p. 9.

162 Mr Rohan Workman, *Official Committee Hansard*, Melbourne, 10 March 2016, p. 54.

163 Mr Rohan Workman, *Official Committee Hansard*, Melbourne, 10 March 2016, pp 57, 58.

164 Mr Doran Ben-Meir, University of Melbourne, *Official Committee Hansard*, Melbourne, 10 March 2016, p. 58.

2.112 Being able to fully explain the business was also fundamental to venture capital company, Reinventure's start-up selection process:

> … if as an entrepreneur you cannot hustle your own cash, if you cannot front an investor directly, then you probably cannot do all the other things that are necessary to build a great company. … If you cannot convince them of your dream, you get nowhere.[165]

## Concluding Comments

2.113 In comparison with other OECD countries Australia has a strong research sector and performs well during the initial stages of the innovation system. Australia performs relatively poorly, however, in university-business collaboration and in commercialising research and innovation.

2.114 The Committee welcomes the creation of Innovation and Science Australia and the development of a strategic plan for science research and innovation for the next 15 years.

2.115 Focusing on Australia's existing strengths and competitive advantages, as suggested by some universities, should not have the effect of excluding other emerging areas of strength where, if Australia moves quickly, it could become a world leader.

2.116 To prosper, Australia's innovation sector must have a continuous supply of skilled people who are willing to drive research and innovation and in so doing create a competitive workforce. The Committee welcomes the NISA initiatives which aim to increase STEM skills and also encourage the participation of women, but considers that the effectiveness of these initiatives needs to be monitored, evaluated and continuously improved.

2.117 Further, Australia should focus on other skills in addition to STEM such as creativity, problem solving, and capitalising on the experience of workers over the age of 50.

2.118 Representatives of the university sector largely welcomed the changes to funding arrangements announced in NISA. The new funding arrangements should provide an incentive for universities to place a greater focus on undertaking research in collaboration with industry. Once implemented it is important that there is a period of policy stability in this area to enable universities to adjust to the new arrangements and make long-term investments in research capacity.

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165 Mr Danny Gilligan, Co-Founder and Managing Director, Reinventure, *Official Committee Hansard*, Sydney, 9 March 2016, p. 8.

2.119 The Committee recognises that SMEs can experience difficulties in finding suitable research partners and financing collaborations with universities.

2.120 The introduction of metrics to take into account university-business collaboration should encourage a change in research culture with a move away from the publish-or-perish approach to a concept/research to commercialisation approach.

2.121 The Committee has identified a number of overseas models which are designed to facilitate university-business collaboration. These and other models could provide important insights into strategies which could be introduced to nurture innovation in Australia.

2.122 More universities are introducing education courses, incubators and accelerators to foster entrepreneurial talent. The Committee welcomes this change, recognising that it indicates universities are adopting a greater focus on innovation and commercialisation.

### Recommendation 1

2.123 **The Committee recommends that Innovation and Science Australia identify emerging industries where strategic research investment could enable Australia to become a world leader.**

### Recommendation 2

2.124 **The Committee recommends that the Department of Education and Training review overseas models of university-business collaboration with a view to identifying strategies which could be introduced in Australia.**