4

Human Capital—Knowledge and Skills

4.1 This chapter examines:

- issues associated with falling numbers of students electing to study scientific, engineering and technical (SET) subjects in schools, universities and vocational education and training;
- the shortage of teachers qualified in SET subjects; and
- the need to develop business skills and entrepreneurship among academics and public sector researchers and in the private sector.

4.2 From evidence to the inquiry three consensus issues related to SET skills and business/entrepreneurial skills have emerged.

4.3 **Consensus Issue 1**—Knowledge-based economies, including Australia, are increasingly reliant on access to a well-educated, scientifically literate and technically skilled workforce. Evidence suggests that Australia already has certain skills shortages and may not be able to meet projected skills needs. Specifically, concerns have been expressed regarding:

- numbers of students electing to study SET subjects in schools and the shortage teachers qualifies in SET subjects; and
- numbers of students electing to study SET subjects at tertiary level.

4.4 **Consensus Issue 2**—Business and entrepreneurial skills are critical to successful innovation. Evidence suggests that Australia's private sector does not adequately foster an entrepreneurial culture and has a shortage of high level business skills to support innovation.

4.5 **Consensus Issue 3**—The potential for innovation to emerge from public sector research and development (R&D) and to thrive will be enhanced if researchers have a better understanding of business and commercial imperatives. Evidence suggests that some of Australia's public sector researchers have a poor understanding of business and lack entrepreneurial skills. Addressing these issues will require:

- increased and improved business and entrepreneurial skills education and training; and
- a cultural shift and organisational reform in PFRIs to provide an environment which appropriately values entrepreneurship and rewards the commercialisation achievements of staff.

4.6 Human capital, defined as 'our stock of knowledge, skills and personal attributes embodied in people', has been identified as a critical factor underpinning innovation capability.[1]

4.7 The essential knowledge, skills and personal attributes required to support technological innovation fall within two broad categories:

- scientific, engineering and technical knowledge and skills, including information and communications technology (ICT); and
- business skills and entrepreneurial capacity.

4.8 Emphasising the important and complementary contribution of both skill sets to technological innovation, the Australian Business Foundation (ABF) stated:

> There is mounting evidence from innovation research and case studies that knowledge is becoming an increasingly important factor in business competitiveness and economic growth. This does not just include the knowledge from science and formal research and development, but market intelligence, tacit or technical know-how, knowledge embedded in capital goods, insights from customer and supplier relationships or strategic partners and learning gathered from past mistakes and failures.[2]

1 Department of Education, Science and Training, *Mapping Australian Science and Innovation Report 2003*, p. 188.

2 Australian Business Foundation, *Submission No. 64*, p. 3.

Scientific, Engineering and Technology Skills

4.9 International comparisons of statistical data have shown that Australia performs well against innovation indicators relating to a highly skilled workforce. Specifically, Australia ranks above the OECD average in terms of the percentage of the labour force that has a tertiary education, the proportion of researchers in the labour force and the number of science and engineering graduates in the labour force.[3]

4.10 The conclusion has been drawn from this data 'that Australia is well positioned to take advantage of graduates' ability to adapt and use emerging technologies in a knowledge driven economy.'[4]

4.11 However, several submissions to the inquiry have expressed concern regarding the possible erosion of this position. In particular, concerns were raised that the supply of SET skills may not be growing sufficiently to meet emerging demand, especially within industry.[5]

4.12 Two significant concerns regarding SET education in schools are:

- a reduction in the number of students electing to study SET-based subjects (particularly mathematics and the physical sciences[6]) in senior schooling years; and
- a shortage of adequately trained and skilled teaching staff for SET subjects.

Early Education

4.13 Mr Stan Jeffery of Integrated Company Growth Services (ICGS) and Director of the University of Ballarat Technology Park, suggested that education reform, starting at school level, is required to address deficiencies in business and entrepreneurial skills:

> We should educate our students 'to create a job and not just look for a job'. Even though Australia has a world-class

3 *Australian Government's Innovation Report 2004-05: Real Results Real Jobs*, pp. 14-15.

4 *Australian Government's Innovation Report 2004-05: Real Results Real Jobs*, p. 15.

5 For example see Citrix Systems Australasia R&D , *Submission No. 5*, p. 3; Australian Academy of Technological Sciences and Engineering, *Submission No. 49*, p. 8, Science Industry Australia, *Submission No. 61*, Attachment 1, p. 53; GBC Scientific Equipment, *Submission No. 76*, pp. 4-5.

6 Physical sciences include chemistry, electronics and physics, but exclude biology and psychology.

> education system, we focus on corporate employees following the large corporate model.
>
> To do this will require a change right back in the early education system to reward the trader attributes and create a nation of business people. An important lesson taken away by the author from his five years working with Toshiba in Sydney was that 'everyone is in sales' at least we have to sell ourselves and our unique talents and gifts.[7]

4.14 Similar views with regard to the need for educational reform within schools to enhance innovation and entrepreneurship were also expressed by others, including Dr Batterham,[8] and a representative of the ATSE who stated:

> It is in the education system as a whole where you just have to teach that culture … [W]e teach people to be employees rather than employers. If you do a project at school, you should be asked how you would set up a business to do A, B and C—that type of thing, something that makes people understand what risk is about and how the total thing fits together, rather than just the bits of it that seem to be there at the present time. It is a cultural thing that, unfortunately, we lack a bit in our education system … [9]

4.15 In its submission, the AIA also suggested that there is a need for significant reform of the school system to support the development of 'a culture of scientific and technological entrepreneurship'.[10]

Student Numbers

4.16 The *Australian Government's Innovation Report 2004–05* noted a steady decline over three decades in the numbers of senior year students electing to study mathematics and science subjects. The data show that year 12 enrolments in physics and chemistry have fallen from approximately 30 per cent in 1976 to below 20 per cent by the mid-to-late 1990s. [11]

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7 Mr S Jeffrey, *Submission No. 25*, p. 9.

8 Dr R Batterham (Chief Scientist to 31 May 2005), *Transcript of Evidence*, 30 May 2005, p. 5.

9 Mr P Laver (Australian Academy of Technological Sciences and Engineering), *Transcript of Evidence*, 4 August 2005, p. 35.

10 Australian Innovation Association, *Submission No. 72*, p. 4.

11 *Australian Government's Innovation Report 2004-05: Real Results Real Jobs*, pp. 78-79.

4.17 The consequences for Australia include a potential shortage of people with skills in the physical sciences, engineering and technologies, as well as a reduction in scientific literacy[12] in the population as a whole.

4.18 Both the Australian Academy of Technological Sciences and Engineering (ATSE) and the Australian Geoscience Council (AGC) expressed concern that falling numbers of school students electing to study SET-based subjects will compromise Australia's future capacity for technological innovation.[13]

4.19 The ATSE suggested that arresting the fall in student numbers electing to study SET-based subjects will require reform of the education system at all levels.[14]

4.20 Mr Neil O'Loghlen of GBC Scientific Equipment submitted that:

> There is a real problem in terms of people going into the hard disciplines through tertiary institutions. My personal belief is that in secondary school they are taught: you do not have to do subjects that you do not enjoy.[15]

4.21 Australia's then Chief Scientist, Dr Robin Batterham, submitted that a better understanding among school students of the relevance and potential applications of SET skills in the workplace is required. He suggested that this might be pursued by the introduction of a focused campaign, making use of current undergraduates or recent graduates as 'ambassadors'.[16]

4.22 One submission highlighted the importance of 'learning through doing' in stimulating interest in science and technology, and developing innovation skills in early childhood. The submission emphasised the contribution of science and technology centres outside the school system, such as Questacon.[17]

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12 Scientific literacy is defined by the Organisation of Economic Cooperation and Development (OECD) as the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity.

13 Australian Academy of Technological Sciences and Engineering, *Submission No. 49*, p. 8; Australian Geoscience Council, *Submission No. 71*, p. 10.

14 Australian Academy of Technological Sciences and Engineering, *Submission No. 49*, p. 8.

15 Mr N O'Loghlen (GBC Scientific Equipment), *Transcript of Evidence*, 4 August 2005, p. 60.

16 Dr R Batterham (Chief Scientist to 31 May 2005), *Transcript of Evidence*, 30 May 2005, p. 6.

17 Questacon is the National Science and Technology Centre, located in Canberra. Children's Discovery Museum, *Submission No. 97*, pp. 1-2.

Teacher Shortages

4.23 In evidence to the Committee, concern was expressed regarding 'an emerging shortage of scientifically trained teachers'.[18] The AGC referred to the findings of a 2005 report prepared for the Australian Council of Deans of Science (ACDS) which concluded:

> The shortage of suitably qualified science teachers is likely to be exacerbated in the coming years as the bulge of 'baby boomers' approach retirement age.[19]

4.24 Other key findings from the ACDS report included:

- Nearly 43 per cent of senior school physics teachers lacked a physics major, and one in four had not studied the subject beyond first-year university.
- One in four senior school chemistry teachers lacked a chemistry major.
- The heads of secondary school science departments have expressed concern regarding the difficulty in recruiting suitably qualified staff.[20]

4.25 Among its recommendations, the ACDS suggested that the federal and state governments, as well as secondary and tertiary education authorities 'cooperate across sectorial, state and territory boundaries to develop a national science teacher workforce plan'.[21]

4.26 Dr Batterham suggested that providing higher education contribution scheme (HECS) incentives for students studying SET-based courses at university could increase the pool of suitably trained individuals who may consider teaching SET subjects in schools as a career option.[22]

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18 For example see Australian and New Zealand Association for the Advancement of Science, *Submission No. 2*, p. 3; Royal Australian Chemical Institute, *Submission No. 22*, p. 1 (refers to RACI Report *Future of Chemistry: Supply and Demand of Chemists 2005*); Australian Geoscience Council, *Submission No. 71*, p. 10.

19 Australian Council of Deans of Science 2005, *Who's Teaching Science? Meeting the Demand for Qualified Science Teachers in Australian Secondary Schools*, Executive Summary, p. x.

20 Australian Council of Deans of Science 2005, *Who's Teaching Science? Meeting the Demand for Qualified Science Teachers in Australian Secondary Schools*, Executive Summary, pp. ix-x.

21 Australian Council of Deans of Science 2005, *Who's Teaching Science? Meeting the Demand for Qualified Science Teachers in Australian Secondary Schools*, Executive Summary, p. viii.

22 Dr R Batterham (Chief Scientist to 31 May 2005), *Transcript of Evidence*, 30 May 2005, pp. 9-10.

4.27 A range of measures have been introduced under the Australian Government's *Backing Australia's Ability* policy that are intended to encourage the development of skills in science, mathematics and technology in schools, and to promote high calibre teaching of those subjects.

4.28 These measures include:

- **Fostering Scientific, Mathematical and Technological Skills and Innovation in Government Schools**; and
- **Boosting Innovation, Science, Technology and Mathematics Teaching**.

4.29 The Fostering Scientific, Mathematical and Technological Skills and Innovation in Government Schools program will provide an estimated $373 million over the next four years to assist students at government schools to develop better science, mathematical and technical skills. The program was initiated in 2001 and will now run to 2010–11, subject to a review in 2007–08. [23]

4.30 The Boosting Innovation, Science, Technology and Mathematics Teaching program was introduced in 2004 and will provide $38.8 million in funding over seven years until 2010–11. The initiative comprises a series of measures intended to promote high calibre teaching of science, technology and mathematics subjects.

4.31 These programs are complemented by the **Australian Government Quality Teacher Program**[24], which was introduced in 2000 with an initial budget commitment of $76 million, and was extended in 2003 with an additional commitment of $82 million to 2005.

4.32 The Quality Teacher Program is intended to:

- update and improve teachers' skills and understanding in priority areas, including science and information technology; and

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23 Initiatives funded under this program include: targeted professional support and direct professional development in numeracy and technology (NSW); school-based centres of excellence and programs to expand teacher and student awareness of science, mathematics and technology, and a review of the science curriculum (Queensland); strategy for kindergarten to Year 7 curriculum to integrate learning approaches to technological activities, professional development support for teachers across the curriculum, particularly in mathematics, science and technology (WA); and a program to improve numeracy in Indigenous students in the middle years (Victoria). *Backing Australia's Ability* fact sheet, accessed 30 May 2006, <backingaus.innovation.gov.au>.

24 The *Quality Teacher Program* is available to both primary and secondary school teachers.

- enhance the status of teaching in both government and non-government schools.

4.33 The Quality Teacher Program also includes $10 million for the establishment of the **National Institute of Quality Teaching and Leadership** (NIQTL). The NIQTL initiative was commended by the Australian Innovation Association (AIA) in its submission to the inquiry.[25]

4.34 The NIQTL was established to support and advance the effectiveness and standing of the teaching profession in Australia. In December 2005, the NIQTL—renamed **Teaching Australia**—was launched as a permanent body with a further $30 million funding from the Australian Government over four years.[26]

Committee Comment

4.35 The Committee concludes that the Australian Government is cognisant of the need to encourage students to study SET-based subjects in schools and to enhance the quality of teaching in these subject areas.

4.36 While it will take some time for the Australian Government's current programs to have a demonstrable impact on innovation and commercialisation outcomes, the Committee notes the importance of such forward planning programs, and urges the Government to continue to make a long-term commitment to funding such programs and monitoring their outcomes.

4.37 In addition, there is a need to foster an entrepreneurial culture in Australia, starting in the early school years and continued through into public and private enterprises. The Committee addresses this need later in the chapter as a whole-of-government series of measures to target the development of entrepreneurial skills.

25 Australian Innovation Association, *Submission No. 72*, p. 9; Department of Education, Science and Training, accessed 18 November 2005, <backingaus.innovation.gov.au>.

26 Teaching Australia, accessed 9 December 2005, <teachingaustralia.edu.au>; Department of Education, Science and Training, accessed 9 March 2006, <dest.gov.au>.

Universities

4.38 Some submissions emphasised the importance to technological innovation of having sufficient tertiary educated graduates in SET-based subjects.[27] Concerns were expressed regarding declining numbers of students electing to study SET-based subjects at tertiary level.[28]

4.39 Australian tertiary graduate statistics indicate that the numbers of science and engineering graduates increased steadily during the 1990s. However, as a percentage of new graduates, the combined proportion of science and engineering graduates (21.6 per cent) in Australia is below the OECD average (23.1 per cent).[29] In particular, the percentage of engineering graduates (7.7 per cent) is low relative to the OECD average (11.8 per cent).[30] Foreign citizens comprise 45.7 per cent of total tertiary graduates.[31]

4.40 At the postgraduate level, between 1989 and 2002 the annual number of Australian PhD graduates in science and engineering has more than doubled (from 527 in 1988 to 1273 in 2003). However, as a percentage of Australian PhD graduates in all disciplines, science and engineering doctorates have decreased from 50.6 per cent in 1998 to 35.6 per cent in 2003.[32]

4.41 In addition to concerns regarding the supply of engineering graduates, the Australian Electrical and Electronic Manufacturers' Association (AEEMA) suggested that the quality of engineering degrees in Australia is declining in universities:

> ... engineering programs concentrate more on individual technologies and research rather than the issues involved in

27 For example see Australian Geoscience Council, *Submission No. 71*, p. 10; BHP Billiton, *Submission No. 88*, p. 2.

28 Mr S Jeffrey, *Submission No. 25*, pp. 10-11; GBC Scientific Equipment, *Submission No. 76*, pp. 4–5.

29 Department of Education, Science and Training, *Australian Science and Innovation System: A Statistical Snapshot 2005*, pp. 177; 182.

30 Department of Education, Science and Training, *Australian Science and Innovation System: A Statistical Snapshot 2005*, p. 177.

31 Department of Education, Science and Training, *Australian Science and Innovation System: A Statistical Snapshot 2005*, p. 177. Further breakdown of the percentage of foreign citizens graduating in science and engineering was not available to the Committee.

32 Department of Education, Science and Training, *Australian Science and Innovation System: A Statistical Snapshot 2005*, p. 178. Further breakdown of the percentage of foreign citizens awarded doctorates in science and engineering was not available to the Committee.

> product design and manufacture. The engineering schools in universities are increasingly constrained financially leading to less exposure of the graduates to world-class design tools and the experience of design implementation. As a consequence, the industry professional workforce is ageing and is falling behind in the professionalism applied to its core functions.[33]

Vocational Education and Training

4.42 The vocational education and training (VET) sector provides non-university post–school learning and educational opportunities across a wide range of subject areas. It aims to provide students with technical skills, trades and knowledge to enter the workforce.

4.43 There has been extensive growth and participation in the sector over the last decade. However, data from the National Centre for Vocational Education Research (NCVER) indicated that total student numbers decreased by 7.1 per cent from 2003 to 2004.[34]

4.44 In 2004, engineering and related technologies (16.2 per cent of students) was the second most popular field of education in VET, after management and commerce (20.6 per cent of students).[35]

4.45 In its submission to the inquiry, the NSW Department of Education and Training argued that the contribution of VET to innovation requires greater recognition.[36]

4.46 Using the outcomes of recent research, the submission argued that VET has a low profile in current government innovation policy:

> The VET sector is notably absent from Federal Government policies and programs on innovation and technology diffusion. The VET sector receives scant attention in the principal government statement on innovation policy, *Backing Australia's Ability—An Innovation Action Plan for the Future* (2001) and receives only a few incidental mentions in the comprehensive description of Australia's innovation system,

33 Australian Electrical and Electronic Manufacturers' Association, *Submission No. 30*, p. 9.

34 National Centre for Vocational Education Research, accessed 9 December 2005, 'Students and Courses 2004', *Australian Vocational Education and Training Statistics;* p. 3, <ncver.edu.au>.

35 National Centre for Vocational Education Research, accessed 9 December 2005, 'Students and Courses 2004', *Australian Vocational Education and Training Statistics;* p. 3, <ncver.edu.au>.

36 NSW Department of Education and Training, *Submission No. 58*, pp. 5-6.

Mapping Australian Science and Innovation – Main Report (2003). TAFE is specifically excluded from ABS measures of higher education R&D activity.[37]

4.47 The NSW Department of Education and Training has been involved in managing an Australian National Training Authority (ANTA)[38] national project focused on skills ecosystems.[39] Through this, the department has reached a number of conclusions regarding VET and the national innovation system. These are that:

- National policy should reflect an understanding of the role and potential contribution of VET to the national innovation system. Specifically, VET may have a significant role in supporting the diffusion of new technologies when innovation is viewed as a series of small, widely diffused, incremental changes, as distinct from one or a few major breakthroughs.
- The VET sector should engage with industry earlier in the product/service development cycle, moving beyond a reactive response to already articulated industry training needs (usually manifested through skill shortages or gaps), to involvement with industry in identifying the barriers to take-up of innovation and technology, and in formulating training and skills development strategies to overcome these barriers.
- The VET sector should engage more extensively and intensively with research funding bodies and programs (e.g. the Cooperative Research Centre (CRC) Program, AusIndustry's Registered Research Agency program and the Australian Research Council programs).[40]

4.48 In addition to fundamental SET skills, in certain industry sectors there are specific technology skills shortages that have the potential to adversely affect innovation.[41] The impact of the skills shortage on Australian businesses has been highlighted by a 2006 Australian Industry Group (AIG) survey which reports:

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37 NSW Department of Education and Training, *Submission No. 58*, p. 5.

38 In July 2005, under new administrative arrangements, the Department of Education, Science and Training assumed responsibility for all Australian National Training Authority initiatives and programs.

39 Skills ecosystems are networks of businesses, groups and organisations that interact to create clusters of skills and workforce capabilities in an industry or a region.

40 NSW Department of Education and Training, *Submission No. 58*, pp. 7-8.

41 KCS Pty Ltd, *Submission No. 24.1*, p. 2; Science Industry Australia, *Submission No. 61, Attachment 1,* p. 29.

- Firms think that skill shortages will be a significant threat to their competitiveness over the next three years. Results from the survey show that the inability to secure skilled staff is the potential barrier to success cited most often by employers – in 74 per cent of responses – ahead of competitive pressures at home and abroad.[42]

4.49 The AIG survey also reported:

> Most employers are having difficulty finding at least some of the skills they need, especially tradespeople, technicians and paraprofessionals, and engineering professionals...Many employers also report that they are having trouble accessing the right 'soft' skills, with large numbers of people, including potential apprentices, not having good, solid basic skills (numeracy and literacy), basic employability skills (punctuality, etc), higher level 'soft' skills (willingness to learn, good communication and teamwork skills, problem solving skills) or, often, the right 'attitude'.[43]

4.50 In a supplementary submission to the inquiry, plastics manufacturer KCS outlined the challenges faced as a consequence of the shortage of skilled toolmakers.[44] In response to the skills shortage, KCS made the decision to establish in-house training to develop the required level of tool making expertise.

4.51 While recognising the value of this training to the business, KCS noted that skills training can be costly and risky, particularly as the skills shortage in the plastics and tooling industry means that a company investing in training risks losing the employee once the training is complete. KCS concluded that 'our training investment can be used to improve the business of our competitors!' and that 'better-targeted support for skills development could alleviate some of these costs'.[45]

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42 Australian Industry Group 2006, *World Class Skills for World Class Industries: Summary Report*, p. 2.

43 Australian Industry Group 2006, *World Class Skills for World Class Industries: Full Report,* Executive Summary, p. ix.

44 KCS Pty Ltd, *Submission No. 24.1*, p. 2.

45 KCS Pty Ltd, *Submission No. 24.1*, p. 2.

Skills—Migration Policy and Practice

4.52 In addition to the Australian education system, another factor which has an impact on the supply of SET skills is the balance of skilled labour gains and losses experienced through immigration and emigration.

4.53 In its submission, BHP Billiton emphasised the importance of being able to 'move key personnel across borders' to support the continuity of innovation.[46]

4.54 Some evidence to the inquiry indicated that businesses had experienced difficulties with Australia's immigration policies.[47] For example, i3 Aerospace Technologies reported that it had encountered:

> Immigration policies [that] block the admission of educated, highly experienced technology professionals that seek to live in Australia...[48]

4.55 Specifically, i3 Aerospace Technologies claimed the following with regard to Australia's immigration policy:

> The Aussie immigration point scheme does not value the intellect or education required for innovation, people such as engineers, scientists, mathematicians, physicists and even science teachers. A PhD in electrical engineering or information technology from a top ranked technology university is valued less than an equivalent age hairdresser!! The system doesn't even award more points for more education, or the nature of that education. The age limitations and points attributed to applicants based on age make no sense either. A highly educated person takes longer to gain an education than a tradesman and will likely be productive much longer than a tradesman. The cut off age for immigration should reflect this fact.
>
> The bottom line is that to promote technology innovation and to 'seed' the innovation landscape with experienced technology innovators and entrepreneurs, Australia should welcome and encourage immigration of those with

46 BHP Billiton, *Submission No. 88*, p. 1.

47 i3 Aerospace Technologies, *Submission No. 1*, p. 1; pp. 5-6, Mr R Grey (GBC Scientific Equipment), *Transcript of Evidence*, 4 August 2005, p. 52.

48 i3 Aerospace Technologies, *Submission No. 1*, p. 1.

> exceptional technical training, experience, and know how. It does the opposite.[49]

4.56 Despite these reported difficulties, statistical data for the five years to 2003-04 indicated that, far from experiencing a skills shortage as a result of a 'brain drain', losses of scientists and engineers through emigration have been offset by net gains through immigration.[50]

4.57 Notably, by far the largest net gain through immigration was in the category of ICT professionals. A 2005 Monash University study claimed that Australia's general skilled migration policy, granting residency to overseas students graduating in ICT from Australian universities, has resulted in an oversupply of ICT professionals.[51]

Committee Comment

4.58 The Committee notes that the Australian Government is responding to the need to maintain a strong skills base in science, engineering and technology based subjects through several *BAA* policy initiatives.

4.59 In 2001 *BAA–I* provided $155 million to support an extra 5 470 higher education places in the target areas of ICT, mathematics and science. In 2003 *BAA–II* extended this support with an additional $199.5 million over five years from 2006–07 to provide an extra 2 000 higher education places in these target areas.

4.60 While it is too early to fully assess the impact of the *BAA* measures introduced to increase the number of graduates in mathematics, the sciences and ICT, the Committee commends the proactive initiatives introduced to date.

4.61 In addition, the **ARC Federation Fellowships** were introduced by the Australian Government to attract highly experienced and skilled scientists to Australia. [52] The ARC noted that 69 Federation Fellowships have been awarded to date, including 21 to returning expatriate Australians and seven to foreign nationals.[53]

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49 i3 Aerospace Technologies, *Submission No. 1*, pp. 5-6.

50 Department of Education, Science and Training, *Australian Science and Innovation System: A Statistical Snapshot 2005*, p. 185.

51 B Kinnaird, 'The Impact of the Skilled Migration Program on Domestic Opportunity in Information Technology', *People and Place*, vol. 12, no. 4, 2005, pp. 67-79.

52 Australian Research Council, *Submission No. 19*, pp. 8-9.

53 Australian Research Council, *Submission No. 19*, p. 8.

4.62 The Committee is also aware that the Australian Government, through the Department of Education, Science and Training (DEST), is conducting a comprehensive audit of SET skills in Australia. The skills audit is being conducted in response to concerns expressed by industry and the academic research community 'that the supply of skills from the education and training system may not be adequate to meet current or future demand for skills.'[54]

4.63 Specifically the skills audit will assess:

> The extent to which Australia's current and future industry and research body needs are being met by the higher education and VET sector in the supply of SET graduates. In particular, it will provide an understanding of where shortages lie and examine:
>
> - the supply of SET skills from all training and education sectors and report on supply trends;
> - public and private sector demand for SET skills from industry, the research community and education providers, both now and into the future;
> - how successful the education sectors are in meeting existing SET skill needs and responding to emerging needs; and
> - the long and short-term trends in the emigration and immigration of SET graduates and the impact this 'brain gain, brain drain' issue will have on Australia's skills base —particularly as we face an ageing workforce and countries with greater research expenditure. Global demand for skills in these fields will also be analysed.
>
> The audit will consider the supply of and demand for science skills across a broad range of SET disciplines and conduct case studies of specific industries.[55]

4.64 The Committee considers the conduct and scope of the skills audit to be both timely and pertinent. In particular the Committee notes that the information obtained regarding future supply of, and demand for, SET skills will enable the Australian Government to further refine existing policies to maximise their alignment with current and emerging needs.

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54 Department of Education, Science and Training, accessed 13 December 2005, *Audit of Science, Engineering and Technology Skills: Discussion Paper,* April 2005, pp. 4-5, <dest.gov.au>.

55 Department of Education, Science and Training, accessed 13 December 2005, *Audit of Science, Engineering and Technology Skills: Discussion Paper,* April 2005, p. 5, <dest.gov.au>.

4.65 With regard to industry specific skills shortages, the Committee notes the Australian Government's *National Skills Shortages Strategy*, which includes initiatives intended to identify skills shortages and implement measures to address workforce skills needs.[56]

4.66 The Committee also notes measures in the 2006–07 Budget intend to alleviate difficulties faced by employers in accessing a range of skills by implementing a national approach to apprenticeships, training and skills recognition. Under the national approach:

> The Australian Government will collaborate with the states and territories on a programme to fund the development of integrated strategies and solutions to labour market needs in selected regions and industries of strategic importance to the Australian economy. [57]

4.67 In particular, mutual recognition of trade skills and licences across states and territories result in greater portability of qualifications, and lead to a mobile workforce with the capacity to respond more effectively to regional skills shortages.[58]

4.68 In addition, the Committee notes the 2006–07 Budget commitment to improving data collection and sharing with regard to skills shortages between the governments. This will facilitate the identification of skills shortages and the development of appropriate responses to address them.[59]

4.69 With regard to concerns expressed in relation to the low profile of the VET sector in Australian Government innovation policy, the Committee notes the July 2005 transfer of responsibility for VET from ANTA to DEST as part of new administrative arrangements.

4.70 The Committee believes that, with the transfer of responsibility for VET to DEST, the profile and contribution of the VET sector will receive appropriate recognition in the Government policy framework.

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56 Department of Education, Science and Training, accessed 27 January 2006, <getatrade.gov.au>.

57 Australian Government 2006, *Budget 2006-07, Budget Paper No. 2*, p. 155.

58 Australian Government 2006, *Budget 2006-07, Budget Paper No. 2*, p. 155.

59 Australian Government 2006, *Budget 2006-07, Budget Paper No. 2*, p. 155.

4.71 The Committee also notes the introduction of *Shaping our Future: Australia's National Strategy for Vocational Education and Training (VET) 2004–2010.*[60] The National Strategy is Government and industry's collective strategy for VET, to ensure that industry will have a highly skilled workforce to support strong performance in the global economy, and that communities and regions will be strengthened economically and socially through learning and employment.

4.72 Implementation of the National Strategy will be reviewed periodically with a formal progress report produced in 2008 and a final evaluation in 2011.

Business and Entrepreneurial Skills

4.73 One of the most prevalent themes in submissions to the inquiry relates to the critical importance of business and entrepreneurial skills to innovation and commercialisation. [61] This applies to innovation in both the private and public sectors.

4.74 For example, the Queensland Government stated:

> The innovation process also requires skills and experience in bringing new products, processes and services to the market place. While scientific and technical skills are required, entrepreneurial, commercialisation, regulatory, patenting, manufacturing, marketing, financing, management and other business skills are also crucial for success.[62]

4.75 Evidence to the inquiry overwhelmingly suggested that Australia lacks people with adequate high level business skills[63] and an entrepreneurial culture[64] supported by skilled and experienced entrepreneurs.

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60 Department of Education, Science and Training, accessed 12 December 2005, *Shaping Our Future*: *Australia's National Strategy for Vocational Education and Training (VET) 2004-2010,* <dest.gov.au>.

61 For example see Australian Institute for Commercialisation, *Submission No. 29*, p. 21; Australian Academy of Technological Sciences and Engineering, *Submission No. 49*, p. 6; Queensland Government, *Submission No. 74*, p. 4.

62 Queensland Government, *Submission No. 74*, p. 4.

63 Business skills include financial management, marketing and sales, intellectual property management, and human resources and management.

64 Entrepreneurial skills are directed toward the identification and screening of opportunities with potential commercial value, as well as the alibility to liaise with the

4.76 In his submission, Mr Scott-Kemmis highlighted the findings of the 1995 Karpin report[65] which reviewed private sector management in Australia. The major findings of the Karpin report were that:

> ... the best of Australia's managers and enterprises are equivalent to the best in the world, but there are too few of them—there is a long tail of poor performers trailing out behind the front runners.
>
> ... in general, while Australian managers have acknowledged strengths, they also have distinct weaknesses, and...these tend to cluster in those areas which are most critical for the successful manager and business profile for the 21st century. These areas include leadership including teamwork and empowerment, people skills including management of a diverse workforce, strategic skills, a learning focus, and international orientation.[66]

4.77 Some submissions emphasised the lack of a strong marketing and sales culture in Australia.[67] As stated by GRP Technology in its submission:

> As Australians we don't have a good marketing CULTURE. Neither do the English / Europeans. The Americans do – it's a way of thinking— the best 'mousetrap' does not win. The best marketed one does win. We need to recognise this issue and do something about it.
>
> We need to educate our innovators that if they don't pay attention to marketing they may as well not bother! Get this silly idea out of their heads that the 'best' product will win.[68]

4.78 A *Westpac Global Entrepreneurship Monitor* (GEM) study reported that:

> ... Australia's national entrepreneurial performance is mediocre...[W]hen it comes to entrepreneurship, we are a nation of quiet under-achievers.[69]

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business community and secure venture capital. Entrepreneurship also encompasses personal attributes such as perseverance, courage, vision, enthusiasm and leadership.

65 D Karpin, 1995, *Enterprising Nation: Renewing Australia's Managers to Meet the Challenges of the Asia-Pacific Century*, Report of the Industry Task Force on Leadership and Management Skills (the Karpin Report), Australian Government Publishing Service, Canberra.

66 Mr D Scott-Kemmis, *Submission No. 99*, pp. 9-10.

67 For example see ACS, *Submission No. 38*, p. 3; GRP Technology, *Submission No. 45*, p. 7.

68 GRP Technology, *Submission No. 45*, p. 7.

4.79 Some submissions suggested that awareness and skills on both sides of the research–industry divide are required for innovative capacity to be maximised.[70] As stated by DEST in its submission:

> Awareness too, for both industry and researchers, to understand the other's environment and culture, to have the capacity to be able to work and understand the constraints of each other's field is an important skill. There is also a demand for commercialisation experts with experience in scientific fields.[71]

4.80 Similarly, while noting the importance of a technologically skilled workforce, Dr Batterham emphasised the necessary complementarity of business skills stating:

> We must also ensure that the [science and technology based] skills that our investment into R&D brings to the mix are married with business skills focussed on industry needs … [72]

4.81 Commenting on the inadequacy of entrepreneurship in Australia, i3 Aerospace Technologies noted that cultural change will be a slow process, stating:

> A major push over many years will be required to help entrepreneurs and SMEs to develop and demonstrate their ability to innovate and succeed. Once the culture is seeded with enough success stories of technology businesses that create substantial value, the process will become self-sustaining. Even with a major increase in well thought out government support, Australia is more than a decade away from this point.[73]

4.82 In his submission to the inquiry, Mr Bruce Williams of Park Bench Technology suggested that the links between education and innovation in Australia should be examined.[74] Specifically, Mr Williams submitted that there is a need to take business skills training

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69 K Hindle and A O'Connor, 'Westpac GEM Australia: A Study of Australian Entrepreneurship in 2004', *Australian Graduate School of Entrepreneurship Research Report Series*, vol. 2, no. 1, 2005, Swinburne University of Technology, Melbourne, p. 3.

70 For example see Department of Education, Science and Training, *Submission No. 20*, p. 15; Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Submission No. 32*, p. 13.

71 Department of Education, Science and Training, *Submission No. 20*, p. 15.

72 Dr R Batterham, *Submission No. 9*, p. 2.

73 i3 Aerospace Technologies, *Submission No. 1*, p. 9.

74 Park Bench Technology, *Submission No. 15*, pp. 1-4.

beyond the traditional Masters of Business Administration (MBA) type degree courses currently available. Mr Williams proposed a 'bottom up' approach to training through the use of business simulation learning tools with the capacity to improve people's ability to identify and address the risks associated with innovation and to enhance communication skills.[75]

4.83 Similarly ATP Innovations stated:

> These [MBA] courses whilst valuable rarely fulfil the needs of those starting a technology based enterprise. It is our experience that MBA graduate[s] starting a business have little relevant knowledge required to sustain their business in the early stage start-up environment.[76]

4.84 Unlike SET skills, which rely heavily on formal education for development, high level business skills are to a greater extent acquired through experience, and aptitude and culture form the basis of entrepreneurship. The experiential and cultural elements of development of business skills and entrepreneurship create particular challenges for government in attempting to address shortages of these skills.

4.85 Nevertheless, evidence to the inquiry has identified key areas that might be targeted in an effort to enhance Australia's business skills and entrepreneurial capabilities. These key areas for skills development include:

- schools and early education;
- the public sector—publicly funded research agencies (PFRAs), universities and the VET sector; and
- the private sector—businesses and industry.

Business and Entrepreneurial Skills Development in the Public Sector—PRFAs and Universities

4.86 The evidence to the Committee identified a general lack of well-developed business and entrepreneurial skills among academics and researchers in publicly funded research settings.[77]

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75 Park Bench Technology, *Submission No. 15*, pp. 2-4.

76 ATP Innovations, *Submission No. 6*, p. 3.

77 For example see Australian and New Zealand Association for the Advancement of Science, *Submission No. 2*, p. 2; Department of Education, Science and Training,

4.87 Several factors have been identified as contributing to the general lack of business and entrepreneurial skills among academics and researchers working in the public sector. In the main these relate to the culture of academia and the lack of real incentives for researchers in the public sector to commercialise their research activities.

4.88 As summarised by DEST:

> ... most university researchers continue to lack the skills and/or the motivation to become entrepreneurs. Part of this issue has been a perceived lack of information regarding commercialisation practices and procedures, another is the culture of the researchers in particular the perception that by commercialising 'you're selling out'. Alternatively they see little real incentive or reward to undertake the commercialisation of their work. And there is no real peer or professional advancement currently associated with commercialisation involvement.[78]

4.89 In relation to the lack of incentives, several submissions suggested that business skills and entrepreneurship among researchers and academics could be enhanced if career paths and promotions were not focused only on academic achievements and publications, but also took into account commercialisation performance where appropriate.[79]

4.90 For example, one of the five most important factors in determining commercialisation success of publicly funded research as listed by Dr John Yencken and Professor Emeritus Murray Gillin was:

> Commitment of the *university governing body* or senior management to research commercialisation giving proper recognition of individual researcher commercialisation performance (alongside teaching research and administration) in award and promotion systems and

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Submission No. 20, pp. 15-16; Dr W Bridge, *Submission No. 39*, p. 3; Australian Geoscience Council, *Submission No. 71*, p. 10; GBC Scientific Equipment, *Submission No. 76*, p. 7.

78 Department of Education, Science and Training, *Submission No. 20*, pp. 15-16.

79 Australian and New Zealand Association for the Advancement of Science, *Submission No. 2*, p. 2; Department of Education, Science and Training, *Submission No. 20*, p. 16; Dr J Yencken and Professor Emeritus M Gillin, *Submission No. 41*, p. 3; Australian Innovation Association, *Submission No. 72*, p. 10; Council for Humanities, Arts and Social Sciences, *Submission No. 77, Attachment 1*, p. 33.

> providing adequate resources to its technology transfer and commercialisation group...[80]

4.91 The need to encourage a more fundamental cultural and attitudinal change was highlighted by evidence reporting a negative perception of commercialisation expressed by some public sector researchers.[81]

Skills Development Programs and Initiatives

4.92 Several different approaches have been proposed to support the development of business and entrepreneurial skills among public sector researchers, or to facilitate access to these skills. These include:

- formal business and entrepreneurial skills training;
- experience obtained through academic placements, secondments or sabbaticals in industry and business; and
- access to business and entrepreneurial skills through commercialisation offices or technology transfer offices.

Formal Business Skills and Entrepreneurship Training

4.93 Formal business and entrepreneurship training is currently offered to public sector researchers and academics through a range of courses, programs and workshops. These include:

- specialised business and entrepreneurial skills development courses, including those offered by universities and through state/territory government initiatives[82]; and
- the CRC program.

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80 Dr J Yencken and Professor Emeritus M Gillin, *Submission No. 41*, p. 3. The other four factors were: 'perceived fairness of arrangements for sharing of commercialisation earnings'; 'availability of business development support'; 'access to finance and other resources for intellectual property development'; and 'the level and quality of selectivity relating to opportunities identified, business planning and resources applied before the new venture is let go'. Dr J Yencken and Professor Emeritus M Gillin, *Submission No. 41*, p. 4

81 Department of Education, Science and Training, *Submission No. 20*, p. 16; National Health and Medical Research Council, *Submission No. 81*, p. 10; Council for Humanities, Arts and Social Sciences, *Submission No. 77*, *Attachment 1*, p. 10.

82 For example see Australian and New Zealand Association for the Advancement of Science, *Submission No. 2*, p. 3; ATP Innovations, *Submission No. 6*, pp. 3-4; Queensland Government, *Submission No. 74*, pp. 4-6; Tasmanian Government, *Submission No. 86*, pp. 5-7.

Specialised Business Skills and Entrepreneurship Courses

4.94 With regard to business and entrepreneurial skills training opportunities for researchers and academics, the Group of Eight noted that:

> Recent years have seen an increasing awareness within Australian universities of the importance of entrepreneurship to technological innovation. There has been particularly strong growth in subjects in entrepreneurship directed at students in science, technology and engineering as well as management. The great majority of university researchers are keenly interested in seeing the full potential of their research realised … Programs designed to enhance researchers' commercial skills and tax and other policies offering incentives that encourage researchers to pursue commercial outcomes do have positive results and should be encouraged.[83]

4.95 Evidence to the inquiry has suggested that there are several issues to be addressed with regard to formal business and entrepreneurial skills training, particularly its delivery to students who have elected to study science or technology-based subjects, rather than subjects that are more closely aligned with business and commerce.

4.96 Concern was expressed that embedding business and entrepreneurial skills training within undergraduate science and technology degree courses might compromise the quality of the degree if core elements of the science/technology were removed to make way for the additional components.

4.97 Dr Wallace Bridge stated in his submission on commercialisation training in tertiary education:

> At an undergraduate level, an obvious solution to the education problem would be to include appropriate business focused subjects in the course work and some universities are taking this approach. However, this strategy can potentially result in the technical coursework being diluted to an extent that the students do not receive sufficient training in the actual science.[84]

83 Group of Eight, *Submission No. 62*, p. 5.

84 Dr W Bridge, *Submission No. 39*, p. 4.

4.98 Also of concern was the fact that much of the current entrepreneurship training is offered as non-award short courses or workshops.[85] It was suggested that, as a consequence, 'for a lot of people they [the courses and workshops] do not have the impact'.[86]

4.99 Professor Frank Larkins of the University of Melbourne questioned the value of placing too much emphasis on formal business and entrepreneurial skills education at undergraduate level. Providing further clarification, Professor Larkins explained that his experience was that at undergraduate level the concepts were abstract and not so well absorbed, while at postgraduate level students had a better understanding of the relevance of these skills to innovation, and consequently were more receptive:

> It is a question of relative impact … Certainly our educational experience is that people learn particular skills best when they feel they need them.[87]

4.100 The cost to the university and the resources required for entrepreneurial training in science and technology degrees were also raised as major impediments that need to be considered and addressed.[88]

4.101 As an alternative to embedding business and entrepreneurial skills training into existing undergraduate degrees, there was some support for encouraging more students to undertake double degree courses or additional study for separate awards combining science and technology with business and entrepreneurship education.[89]

4.102 Dr Bridge concluded that:

> DEST must update the current education of PhD science students to include formal training in the essential business skills required to recognise and drive commercial opportunities arising from scientific discovery. Without this training, Australia's scientists will continue to be inadequate in recognising and managing financial, technical and market

85 Dr W Bridge, *Submission No. 39*, pp. 4–5.

86 Ms S Bell (La Trobe University), *Transcript of Evidence*, 4 August 2005, p. 6.

87 Professor F Larkins (University of Melbourne), *Transcript of Evidence*, 4 August 2005, p. 12.

88 Ms S Bell (La Trobe University), *Transcript of Evidence*, 4 August 2005, pp. 6-7; Dr C Day (Melbourne Ventures), *Transcript of Evidence*, 4 August 2005, p. 9.

89 Dr W Bridge, *Submission No. 39*, p. 4; Professor P Pigram (La Trobe University), *Transcript of Evidence*, 4 August 2005, pp. 10-11.

> risk, which will continue to inhibit Australia's ability to become a significant player in the emerging global high technology industry sectors. The preferred model would be a revised APA (Australian Postgraduate Award) scholarship for PhD students that would fund a four year combined PhD/MBA (or similar, specifically designed for scientists).[90]

4.103 One business and entrepreneurial skills training initiative that received support in a number of submissions to the inquiry is the Australian Institute for Commercialisation (AIC)'s Commercialisation Bootcamp.[91] This initiative specifically targets public sector researchers and scientists.

4.104 Dr Rowan Gilmore of the AIC outlined the objectives and structure of the Commercialisation Bootcamp stating:

> It is a program predominantly to try and change the culture of an organisation and to win the hearts and minds of researchers so that they understand that their research may have market outcomes. It is a two-day program in which we start out by talking a little bit about commercialisation and then talk about the value of IP [intellectual property], the potential need to protect IP, and some of the dilemmas that researchers face in terms of publishing versus disclosing research. We bring in successful entrepreneurs who have founded start-up companies themselves. They give their stories. We talk about what venture capitalists are after and we basically describe the potential paths to market, the importance of considering markets if you do want to take IP downstream, the importance of partnerships, the importance of building a team and so on.[92]

4.105 In response to a question regarding the extent to which a short training course, such as the Commercialisation Bootcamp, could influence attitudinal change in the research sector, Mr Alex Blauensteiner of the AIC stated:

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90 Dr W Bridge, *Submission No. 39*, p. 1.

91 ATP Innovations, *Submission No. 6*, p. 3; Cooperative Research Centres Committee, *Submission No. 11*, p. 4; Queensland Government, *Submission No. 74*, p. 3; Tasmanian Government, *Submission No. 86*, p. 7; Ms S Bell (La Trobe University), *Transcript of Evidence*, 4 August 2005, p. 6.

92 Dr R Gilmore (Australian Institute for Commercialisation), *Transcript of Evidence*, 5 September 2005, p. 4.

> I think a two-day boot camp is a starting point. I would not see it as the be all and end all to solving an issue like that. Realistically, you are talking about a massive cultural change within academia, and that is something that is being thrust upon them in one way or another. I think it is going to take a little bit of time.[93]

4.106 Some evidence to the inquiry argued that, as entrepreneurship is essentially innate, it cannot be taught or learned effectively. However it was suggested that entrepreneurship could be better supported by the provision of an environment conducive to the development of entrepreneurial skills in those individuals that demonstrate a natural aptitude.

4.107 Representing the ATSE, Mr Laver argued that:

> Entrepreneurship is a bit like football: you cannot teach it, even if you have some basic skills, but you can actually refine it by doing some things. So I am not exactly sure the academy [ATSE] believes this rush to teach entrepreneurship in universities is quite as productive as it might be.[94]

4.108 Rather than focussing too heavily on formal business and entrepreneurial skills training, the ATSE suggested the introduction of a range of strategies to enhance support for entrepreneurs, including to:

- send young technology graduates overseas for experience, and have policies in place to get them back.
- provide incentives for established overseas companies to provide training opportunities for technological management.
- establish an expatriate register, sponsored by the Government.
- provide assistance to companies to repatriate Australians back to Australia.
- have policies to boost training and mentoring of technological entrepreneurs.[95]

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93 Mr A Blauensteiner (Australian Institute for Commercialisation), *Transcript of Evidence*, 5 September 2005, p. 7.

94 Mr P Laver (Australian Academy of Technological Sciences and Engineering), *Transcript of Evidence*, 4 August 2005, p. 33.

95 Australian Academy of Technological Sciences and Engineering, *Submission No. 49*, p. 6.

Cooperative Research Centres

4.109 As part of its role in building linkages between research and industry, the CRC program has 'a strong education component with a focus on producing graduates with skills relevant to industry needs.'[96]

4.110 Representatives of the CRC Association and of the CRC Committee asserted that postgraduates trained in the CRC operating environment were not only technically trained, but also had well-developed business skills, effectively making them 'workplace ready'.[97]

Experience in Industry and Business

4.111 Another mechanism by which researchers and academics working in the public sector can acquire an improved understanding of business skills and entrepreneurship is through direct experience working in business or industry.

4.112 Support for measures that facilitate the mobility of researchers between PFRIs and industry was expressed in several submissions to the inquiry.[98]

4.113 The Commonwealth Scientific and Industrial Research Organisation (CSIRO) noted that:

> People who have experiences both from industry and from within a research organisation can be especially effective at bridging the divide. Encouraging even more interactions between researchers and people from industry through secondments, joint appointments and other mechanisms could greatly improve technology transfer across the board.[99]

4.114 The AIA identified a number of measures that might facilitate researcher mobility between the public and private sector. These included the introduction of flexible employment contracts for

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96 Department of Education, Science and Training, accessed 16 December 2005, <crc.gov.au>.

97 Cooperative Research Centres Association, *Submission No. 48*, pp. 1-2; Cooperative Research Centres Committee, *Submission No. 11*, p. 4.

98 Australian Research Council, *Submission No. 19*, p. 6; Department of Education, Science and Training, *Submission No. 20*, p. 15; Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Submission No. 32*, p. 15; Robert Taylor and Associates, *Submission No. 34*, p. 6; Australian Academy of Technological Sciences and Engineering, *Submission No. 49*, pp. 5-6; Australian Innovation Association, *Submission No. 72*, p. 10.

99 Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Submission No. 32*, pp. 7-8.

university researchers allowing them to spend periods away from their institutions to work with R&D companies, and providing science and engineering students with the opportunity to spend time in their final year of study working in the business R&D setting.[100]

4.115 The AIC also supported the introduction of initiatives to 'promote mobility and enable exchanges of staff between government labs, universities and industry', suggesting that government might:

> Develop appropriate incentive schemes, protect tenure (where applicable) and ensure pension rights are unaffected in order to enable such exchanges.[101]

4.116 To address the issue of relatively low levels of mobility of researchers between the public and private sectors in Australia, the National Health and Medical Research Council (NHMRC) introduced **Industry Fellowships** for researchers working within the clinical and biomedical sciences. The NHMRC explained that:

> Industry Fellowships were established to develop the commercialisation skills available to researchers. The objectives of the scheme are to:
>
> - Provide a vehicle for Australian researchers to gain experience in industrial research including project planning, business planning, and knowledge of business and industry dynamics; and
> - Increase knowledge of the commercial aspects of R&D within research institutions.[102]

4.117 The NHMRC reported that the numbers and quality of applications have fluctuated since the scheme was introduced in 2002. Consequently, the NHMRC is considering a range of recommendations to revise the scheme and make it more attractive to both researchers and industry.[103]

4.118 Further, the ARC outlined the role of its **Linkage Projects** scheme as a mechanism to encourage commercial skills development via enhanced mobility:

> Lack of mobility is a significant barrier to collaboration, due in most instances, to inflexible and widely different conditions of employment and remuneration across different

100 Australian Innovation Association, *Submission No. 72*, p. 10.

101 Australian Institute for Commercialisation, *Submission No. 29*, p. 31.

102 National Health and Medical Research Council, *Submission No. 81*, p. 3.

103 National Health and Medical Research Council, *Submission No. 81*, p. 4.

> sectors. One of the best ways to transfer knowledge or technology from the performers to the users of research is to transfer people. Without this capability it becomes very inefficient to transfer knowledge from one organisation to another. The ARC's Linkage Projects scheme is aimed, in part, at trying to 'break-down' this barrier and it has been successful particularly at the postgraduate level. In the last funding round under the scheme, 426 Australian Postgraduate Awards (Industry) were awarded. [104]

4.119 While the NHMRC Industry Fellowships and the ARC Linkage Projects provide opportunities for researchers and academics to obtain experience working in industry, one submission received from a business argued for the introduction of a mandatory period spent working in industry for all public scientists.[105]

Commercialisation and Technology Transfer Offices

4.120 An alternative to developing the business and entrepreneurial capabilities of academics and researchers is to ensure that these skills are accessibly located within PFRA and university commercialisation offices or technology transfer offices (TTOs). Several submissions emphasised the importance of easy access to skilled technology transfer and commercialisation office staff 'to help steer technologies through the commercialisation process'.[106]

4.121 In support of this approach, Dr Yencken and Professor Emeritus Gillin submitted that:

> The Committee may wish to support the initiative of the Australian Institute of Commercialisation in running *boot camps* for academic researchers to increase their ability to find commercial opportunities arising from their research. The literature however draws attention to the danger of turning good researchers into poor entrepreneurs. A recent consultancy for the Department of Education, Science and Training (Yencken and Ralston, 2005) has concluded that the most effective incentive to academic researchers to commercialise their research outcomes and to make available

104 Australian Research Council, *Submission No. 19*, p. 6.

105 Environment Research and Information Consortium Pty Ltd, *Submission No. 28*, p. 10.

106 Melbourne Ventures, *Submission No. 21*, p. 1; Also see Department of Education, Science and Training, *Submission No. 20*, p. 15; Knowledge Commercialisation Australasia, *Submission No. 27*, p. 7; La Trobe University, *Submission No. 35*, pp. 3-4.

> the required opportunity assessment, intellectual property assessment and deal making skills has been the deployment of the right type of business development people close by the researchers, that is in the faculties and research centres.[107]

4.122 Melbourne Ventures, established in 2004 by the University of Melbourne, is an example of a technology transfer company.[108] Specifically Melbourne Ventures provides access to a team which:

> ... assists in the commercialisation of research-based intellectual property by facilitating access to business development expertise, development funds, and management skills to run technology-based start-ups, and secure licences for University Intellectual Property. Our seasoned team has experience in a wide range of commercial environments, and access to all the necessary elements to enable the successful coordination of the commercialisation process.[109]

4.123 In its submission, Melbourne Ventures outlined the assistance provided by its commercialisation team to the establishment of the start-up biomedical company Cryptopharma. Specifically, the commercialisation team provided Crytopharma with support in patent management and strategic business development.[110]

4.124 Some submissions expressed concern that the requisite level of business knowledge was not currently available through many TTOs.[111] The need for adequate funding to enable TTOs to attract and retain appropriately skilled personnel was highlighted by the Group of Eight:

> Skilled commercial managers are highly sought after internationally and are expensive to both attract and keep. Unless adequately resourced, university commercial offices will struggle to employ the calibre of staff required to deliver on the commercial potential of their patent portfolios.[112]

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107 Dr J Yencken and Professor Emeritus M Gillin, *Submission No. 41*, p. 3.

108 Melbourne Ventures, *Submission No. 21*, pp. 1-3.

109 Melbourne Ventures, accessed 24 January 2006, <research.unimelb.edu.au>.

110 Melbourne Ventures, *Submission No. 21*, pp. 2-3.

111 Biomedical Consulting Services, *Submission No. 16*, p. 2; Dr M Sceats, *Submission No. 23*, p. 20, QPSX, *Submission No. 47*, p. 9.

112 Group of Eight, *Submission No. 62*, p. 5.

4.125 Knowledge Commercialisation Australasia (KCA), a body representing the organisational units that provide outreach services for the majority of Australia's universities and for some PFRAs, suggested consideration be given to:

> ... direct support or rebate to the establishment and/or running of a commercialisation technology transfer office.
>
> - Minimum requirements for qualification might be that the university has committed to at least a dedicated resource of 2 full time equivalent (FTE) for three (3) years.
> - For an established office, a separate formula could be developed.[113]

Committee Comment

4.126 The lack of business skills and entrepreneurship apparent among some researchers, scientists and academics in the public sector poses significant challenges for the commercialisation of technological innovation emerging from PFRAs and universities.

4.127 The Committee considers that no single approach will address these issues. Therefore the Committee supports a multi-faceted approach combining all the elements of business and entrepreneurial skills education and training, enhanced mobility between the public and private sectors, and access to business skills through TTOs.

4.128 With regard to formal business and entrepreneurial skills education and access to skills through TTOs, the Committee notes the submissions that consider additional dedicated funding and resources are needed. This forms part of the case made in a number of submissions to the inquiry for government to provide 'third stream funding'.[114] The case for third stream funding is considered by the Committee later in the report (see discussion in chapter five).

4.129 In relation to staff mobility between the public and private sectors, the Committee is concerned that opportunities are limited by institutional and organisational barriers (e.g. limits on the transferability of accrued entitlements, such as leave, and on the ability to continue contributions to some superannuation schemes). In addition, business

113 Knowledge Commercialisation Australasia, *Submission No. 27*, p. 8.

114 'Third stream funding' describes additional funding for universities to support business and community engagement activities. These outreach activities complement universities' two traditional activity sets of teaching and research.

acumen, entrepreneurship and commercial achievements are not always taken into account in promotions within PFRIs.

4.130 The diversity of PFRI structures across Australia means that a 'one-size-fits-all' approach is not appropriate to address the issues of governance, staff priorities, promotion structures and mobility opportunities. However, there are common barriers to an improved culture of innovation, commercialisation and entrepreneurship, and there will be some common responses that can address these impediments.

4.131 Accordingly, the Committee recommends that a study be conducted into appropriate entrepreneurial incentives and new models for rewarding entrepreneurship within PFRIs. The study should consider mechanisms for overcoming jurisdictional issues that hinder the mobility of researchers between the public and private sectors.

4.132 The Committee strongly recommends that PFRIs implement options identified by this study and adapt their governance and incentive structures in line with the outcomes of the study. The Committee considers that, as a prerequisite for building a case for third stream funding, universities must be able to demonstrate that they have maximised their capacity for innovation and opportunities for entrepreneurship within existing resources (see discussion in chapter five).

Recommendation 3

The Committee recommends that the Department of Education, Science and Training, in conjunction with the Australian Vice-Chancellors' Committee and publicly funded research agencies:

- **conduct a study into jurisdictional, promotion, mobility and cultural issues in publicly funded research agencies and universities which may impede an entrepreneurial culture and innovation; and**
- **develop options for universities and publicly funded research agencies to provide governance structures and incentives which encourage business and entrepreneurial skills and commercial outcomes within these organisations.**

4.133 The Committee notes that its comments and recommendations under the heading 'Fostering a Culture of Entrepreneurship in Australia' later in this chapter apply to the public sector as well as the private sector.

Business and Entrepreneurial Skills Development in the Private Sector

4.134 Examining the skills and capabilities sought by innovating businesses in Australia, the ABS *Innovation in Australian Business Survey 2003* revealed that general business and marketing skills were the skills most frequently sought by businesses developing new products, goods or services.[115]

4.135 With regard to developing business skills and entrepreneurial ability in the business setting, experience, complemented by on the job training, and mentorship from experienced entrepreneurs, emerged as important elements.[116]

4.136 The ABS *Innovation in Australian Business Survey* found that most innovative businesses looked to source sought-after skills from people already working in the business, emphasising the importance of experience to the development of skills competency.[117]

4.137 While formal training can provide a basis for the development of business skills, it has been asserted that higher level competency is usually only developed through experience. Reporting on the outcome of the 2003 Symposium in its submission, the ATSE noted that the majority of the speakers had emphasised the importance of 'learning on the job'.[118]

4.138 Of note with regard to supporting the development of business skills in the private sector is the Department of Industry, Tourism and Resources (DITR)'s **Commercialising Emerging Technologies** (COMET) program. The COMET program, introduced in 1999–2000 was described as:

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115 Australian Bureau of Statistics, *2003 Innovation in Australian Business Survey* (ABS 8158.0), p. 50.

116 For example see Australian Academy of Technological Sciences and Engineering, *Submission No. 49*, p. 6; Mr M Cochran, *Submission No. 73*, p. 9.

117 Australian Bureau of Statistics, *2003 Innovation in Australian Business Survey* (ABS 8158.0), p. 50.

118 Australian Academy of Technological Sciences and Engineering, *Submission No. 49*, p. 6.

> ... a competitive grants program that supports early-growth stage and spin off companies to successfully commercialise their innovations by providing access to business services and advice.[119]

4.139 Specifically, COMET business advisers are private sector consultants engaged to assist in the delivery of the COMET program. Business advice is available in the following areas:

- management development including participation in approved management skills development courses;
- engagement of mentors;
- strategic and business planning, including an export strategy if appropriate;
- market research;
- market validity;
- *Intellectual Property* strategy; and
- *Proven Technology* (including finalising *Working Prototypes*).[120]

4.140 Evidence was generally supportive of the COMET program. An independent assessment of the Australian Government innovation programs provided in an attachment to one submission concluded:

> The program that clearly shines here is COMET … It has been directed at very early stage ventures and is the only program to evaluate the potential of the applicant with regard to their perceived entrepreneurial abilities.[121]

4.141 However, the restriction of the scheme to new, start-up companies has been criticised, with some evidence suggesting that the kind of business advice and venture capital raising assistance available through COMET could also be useful to companies that are more established.[122]

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119 IR&D Board, *Submission No. 53*, p. 1.

120 AusIndustry, *Commercialising Emerging Technologies – COMET, Customer Information Guide,* p. 2.

121 Dr J Yencken and Professor Emeritus M Gillin, *Submission No. 41*, *Attachment 1*, p. 14.

122 Environment Research and Information Consortium Pty Ltd, *Submission No. 28*, p. 7; S Hudson and Associates, *Submission No. 80*, p. 11.

Committee Comment

Business Skills in the Private sector

4.142 Despite the critical importance of business skills to successful innovation the Committee notes that data on the number of business/commerce graduates and their contribution to the workforce is not included in DEST's annual *Australian Science and Innovation System: A Statistical Snapshot*.

4.143 The Committee acknowledges that there may be several reasons why data on business skills has not been included in this publication. For example, it may simply reflect the historical absence of business skills data in science and innovation statistics.

4.144 Alternatively, the exclusion of business skills data may be a consequence of the ongoing international debate regarding the range of appropriate innovation indicators and statistics, and concurrent efforts to standardise innovation metrics frameworks. Furthermore, as the development of high level business skills relies more on experience than formal training, objective statistic measures such as graduate numbers are likely to be less informative with regard to Australia's business skills competency.

4.145 In any event, evidence to the inquiry suggested that business skills may be in short supply. DEST's 2003 *Mapping Science and Innovation Report* indicated that Australia does not compare well internationally with regard to formal business and management training, relative to other major industrialised countries.[123]

4.146 Given the importance of business skills to innovation and commercialisation, the Committee considers it essential to have adequate trend data tracking this connection. Accordingly, the Committee recommends DEST include data on business skills in the human resources section of its annual *Australian Science and Innovation System: A Statistical Snapshot.* At a minimum, this data should include information on the number of new business/commerce graduates and their workforce participation rates.

123 Department of Education, Science and Training, *Mapping Australian Science and Innovation Report 2003*, p. 241.

Recommendation 4

The Committee recommends that the Department of Education, Science and Training expand its annual *Australian Science and Innovation System: A Statistical Snapshot* to include the following data:

- **the number of students with combined science, engineering, technology/business/commerce degree qualifications;**
- **state and territory breakdowns of science, engineering, technology graduates;**
- **breakdown by subject and qualification of the number of foreign citizens with science, engineering, technology qualifications graduating from Australian universities; and**
- **science, engineering, technology graduate workforce participation rates.**

4.147 The Committee recognises the challenges faced by businesses in supporting the ongoing development of business and entrepreneurial skills. The Committee notes that DITR's COMET program is targeting business skills development in new start-up companies to enhance competency in these areas. The Committee was impressed by the strong support for the COMET program, which evidently addresses a business need for mentoring and market advice.

4.148 While the need for business skills mentoring may be most pronounced in start-up companies, it is certainly not restricted to start-up companies. During inspections conducted in the course of its inquiry, members of the Committee had informal discussions with representatives of a number of companies who referred to the difficulties experienced, and mistakes made, due to a lack of business knowledge and skills.

4.149 In considering whether the mentoring and marketing advice available through COMET should be extended to more established companies, the Committee notes the recent introduction of another DITR initiative—the **Small Business Entrepreneurship Program** (SBEP).

4.150 SBEP is intended to provide skills development, incubation and advisory services to small business owners and managers throughout Australia. Applications for funding under the SBEP were called for in November 2005 and the successful applicants will be announced in 2006.[124]

4.151 The Committee considers that the SBEP should serve a similar purpose for established businesses as COMET provides for start-ups. The Committee anticipates that the effectiveness of the program will be assessed as part of routine monitoring activities.

Fostering a Culture of Entrepreneurship in Australia

4.152 The Committee acknowledges the importance of entrepreneurial skills to innovation, technology transfer and the commercialisation process. Evidence has suggested that, in addition to fundamental reform at all levels of the education system, a cultural shift is required.

4.153 The Committee notes that the Australian Government, through DEST and DITR, currently supports a range of initiatives under the **National Innovation Awareness Strategy** (NIAS). The NIAS aims to raise awareness among young Australians, SMEs, and the broader community of the economic benefits of innovation and entrepreneurship.[125]

4.154 Given the clear association between entrepreneurship and innovation, and the need for Australia to match global efforts in this area in order to improve, or at least maintain, productivity and economic wealth, promoting cultural shift to develop a culture of entrepreneurship must be considered.

124 Still to be announced at time of writing. AusIndustry, accessed 30 May 2006, <ausindustry.gov.au>.

125 Department of Industry, Tourism and Resources, accessed 21 December 2005, <innovation.gov.au>.

4.155 While the *BAA* framework of programs is commendable for the support it provides for R&D, the Committee concludes that Australia must now foster the culture of innovation and generation of innovators that can maximise the considerable investment of *BAA*.

4.156 Fostering a culture of entrepreneurship is a critical early step in improving Australia's pathways to innovation. It is also a challenging task for government. Formulating a program by which a government might foster such a cultural shift and engender a more entrepreneurial culture, requires the expertise of educators, researchers, industry specialists and social theorists at a minimum.

4.157 Accordingly, the Committee recommends that a whole-of-government taskforce be established to investigate a suite of appropriate policy and program measures to foster national culture of entrepreneurship.

Recommendation 5

The Committee recommends that the Australian Government establish a dedicated whole-of-government taskforce to develop a series of measures targeting the early development of entrepreneurial skills in the education system (including the early school years) and the broader community. To inform the development of these measures, the Committee recommends that the taskforce draw upon the expertise of educators, researchers and industry specialists.